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~~North~~ Carolina State University • Raleigh

Graduate Catalog
1968-70

~~North~~ Carolina State Record

NORTH CAROLINA STATE RECORD

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North Carolina State University • Raleigh

Graduate Catalog 1968-70

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The Executive Council for the Graduate School is made up of members of the Advisory Boards of each of the three units of the Consolidated University. The President, the Vice-president for Academic Affairs, the Chancellors and the graduate deans are ex-officio members of the Executive Council.

THE ADMINISTRATIVE BOARDS

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THE CALENDAR

FALL SEMESTER, 1967

September 5	Tues.	General faculty meeting; last day to pre-register for fall courses.
September 8-10	Fri.-Sun.	Complete registration and pick up class schedules.
September 11	Mon.	First day of classes.
September 15	Fri.	Last day to add a course. <i>Last day for filing application for admission to candidacy for students expecting to complete requirements for the master's degree in January, 1968.</i>
September 22	Fri.	Last day to withdraw (or drop a course) with refund; last day to drop a course without a grade.
November 4	Sat.	Mid-term reports due. <i>Last day for taking qualifying examinations for students expecting to receive doctorate in May, 1968.</i>
November 6	Mon.	<i>Meeting of the Graduate Executive Council of the University of North Carolina.</i>
November 21	Tues.	Thanksgiving holidays begin at 10:00 p.m.
November 27	Mon.	Classes resume at 8:00 a.m.
December 15	Fri.	<i>Deadline for submission of theses in final form to Graduate School by candidates for the master's and doctoral degrees in January, 1968. Last day for taking final oral examinations for master's degrees not requiring theses.</i>
December 16	Sat.	Christmas holidays begin at 1:00 p.m.
January 3	Wed.	Classes resume at 8:00 a.m.
January 10	Wed.	Last day of classes.
January 11	Thurs.	Reading day.
January 12-19	Fri.-Fri.	<i>Final examinations.</i>
January 15	Tues.	<i>Meeting of the Graduate Executive Council of the University of North Carolina.</i>

SPRING SEMESTER, 1968

January 23	Tues.	Last day to preregister.
January 26-28	Fri.-Sun.	Complete registration and pick up class schedules.
January 29	Mon.	First day of classes.
February 2	Fri.	Last day to add a course. <i>Last day for filing application for admission to candidacy for students expecting to complete requirements for the master's degree in May and July, 1968.</i>

February 9	Fri.	Last day to withdraw (or drop a course) with refund; last day to drop a course without a grade.
March 16	Sat.	Mid-term reports due.
March 23	Sat.	<i>Last day for taking qualifying examinations for students expecting to receive doctorate in August, 1968.</i>
April 8	Mon.	<i>Meeting of the Graduate Executive Council of the University of North Carolina.</i>
April 10	Wed.	Easter holidays begin at 10:00 p.m.
April 17	Wed.	Classes resume at 8:00 a.m.
April 18	Thurs.	<i>Deadline for submission of theses in final form to Graduate School by candidates for the master's and doctoral degrees in May, 1968. Last day for taking final oral examinations for master's degrees not requiring theses.</i>
May 15	Wed.	Last day of classes.
May 16	Thurs.	Reading day.
May 17-24	Fri.-Fri.	Final examinations.
May 25	Sat.	Commencement.

SUMMER SESSIONS, 1968

First Session

May 24	Fri.	Last day to preregister.
June 4	Tues.	Registration and payment of fees; late registration fee for those who register after 1:00 p.m., June 4.
June 5	Wed.	First day of classes.
June 10	Mon.	Last day to register; last day to withdraw (or drop a course) with refund; last day to drop a course without a grade.
June 11	Tues.	<i>Last day for filing application for admission to candidacy for students expecting to complete requirements for the master's degree in August, 1968.</i>
June 14	Fri.	<i>Deadline for submission of theses in final form to Graduate School by candidates for the master's and doctoral degrees in July, 1968. Last day for taking final oral examinations by candidates for master's degrees not requiring theses.</i>
June 26	Wed.	<i>Last day for taking qualifying examinations for students expecting to receive doctorate in January, 1969.</i>
July 11	Thurs.	Last day of classes.
July 12	Fri.	Final examinations.

Second Session

July 4	Thurs.	Last day to preregister.
July 16	Tues.	Registration and payment of fees; late registration fee for those who register after 12:00 noon, July 16.
July 17	Wed.	First day of classes.
July 18	Thurs.	Last day to register; last day to withdraw (or drop a course) with refund; last day to drop a course without a grade.
July 25	Thurs.	<i>Deadline for submission of theses in final form to Graduate School by candidates for the master's and doctoral degrees in August, 1968. Last day for taking final oral examinations by candidates for master's degrees not requiring theses.</i>
August 21	Wed.	Last day of classes.
August 22	Thurs.	Final examinations.

FALL SEMESTER, 1968

September 9	Mon.	General faculty meeting.
September 10	Tues.	Last day to preregister for fall courses.
September 13-15	Fri.-Sun.	Complete registration and pick up class schedules.
September 16	Mon.	First day of classes.
September 20	Fri.	Last day to add a course. <i>Last day for filing application for admission to candidacy for students expecting to complete requirements for the master's degree in January, 1969.</i>
September 27	Fri.	Last day to withdraw (or drop a course) with refund; last day to drop a course without a grade.
November 9	Sat.	Mid-term reports due. <i>Last day for taking qualifying examinations for students expecting to receive doctorate in May, 1969.</i>
November 26	Tues.	Thanksgiving holidays begin at 10:00 p.m.
December 2	Mon.	Classes resume at 8:00 a.m.
December 18	Wed.	Christmas holidays begin at 10:00 p.m.
December 20	Fri.	<i>Deadline for submission of theses in final form to Graduate School by candidates for the master's and doctoral degrees in January, 1969. Last day for taking final oral examinations for master's degrees not requiring theses.</i>
January 6, 1969	Mon.	Classes resume at 8:00 a.m.

January 15	Wed.	Last day of classes.
January 16	Thurs.	Reading day.
January 17-24	Fri-Fri.	Final examinations.

SPRING SEMESTER, 1969

January 28	Tues.	Last day to preregister.
January 31- February 2	Fri.-Sun.	Complete registration and pick-up class schedules.
February 3	Mon.	First day of classes.
February 7	Fri.	Last day to add a course. <i>Last day for filing application for admission to candidacy for students expecting to complete requirements for the master's degree in May and July, 1969.</i>
February 14	Fri.	Last day to withdraw (or drop a course) with refund; last day to drop a course without a grade.
March 29	Sat.	Mid-term reports due. <i>Last day for taking qualifying examinations for students expecting to receive doctorate in August, 1969.</i>
April 2	Wed.	Easter holidays begin at 10:00 p.m.
April 8	Tues.	Classes resume at 8:00 a.m.
April 24	Thurs.	<i>Deadline for submission of theses in final form to the Graduate School by candidates for the master's and doctoral degrees in May, 1969. Last day for taking final oral examinations by candidates for master's degrees not requiring theses.</i>
May 21	Wed.	Last day of classes.
May 22	Thurs.	Reading day.
May 23-30	Fri.-Fri.	Final examinations.
May 31	Sat.	Commencement.

SUMMER SESSIONS, 1969*First Session*

May 29	Thurs.	Last day to preregister.
June 9	Mon.	Registration and payment of fees; late registration fee for those who register after 1:00 p.m., June 9.
June 10	Tues.	First day of classes.
June 13	Fri.	Last day to register; last day to withdraw (or drop a course) with refund; last day to drop a course without a grade.
June 16	Mon.	<i>Last day for filing application for admission to candidacy for students expecting to complete requirements for the master's degree in August.</i>

June 20	Fri.	<i>Deadline for submission of theses in final form to Graduate School by candidates for the master's and doctoral degrees in July. Last day for taking final oral examinations by candidates for master's degrees not requiring theses.</i>
July 1	Tues.	<i>Last day for taking qualifying examinations for students expecting to receive doctorate in January, 1970.</i>
July 4	Fri.	Holiday.
July 17	Thurs.	Last day of classes.
July 18	Fri.	Final examinations.

Second Session

July 10	Thurs.	Last day to preregister.
July 22	Tues.	Registration and payment of fees; late registration fee for those who register after 12:00 noon, July 22.
July 23	Wed.	First day of classes.
July 28	Mon.	Last day to register; last day to withdraw (or drop a course) with refund; last day to drop a course without a grade.
August 1	Fri.	<i>Deadline for submission of theses in final form to Graduate School by candidates for the master's and doctoral degrees in August. Last day for taking final oral examinations by candidates for master's degrees not requiring theses.</i>
August 28	Thurs.	Last day of classes.
August 29	Fri.	Final examinations.

FALL SEMESTER, 1969

September 8	Mon.	General faculty meeting.
September 9	Tues.	Last day to preregister for fall courses.
September 12-14	Fri.-Sun.	Complete registration and pick up class schedules.
September 15	Mon.	First day of classes.
September 19	Fri.	Last day to add a course. <i>Last day for filing application for admission to candidacy for students expecting to complete requirements for the master's degree in January, 1970.</i>
September 26	Fri.	Last day to withdraw (or drop a course) with refund; last day to drop a course without a grade.
November 1	Sat.	Mid-term reports due. <i>Last day for taking qualifying examinations for students expecting to receive doctorate in May, 1970.</i>

November 25	Tues.	Thanksgiving holidays begin at 10:00 p.m.
December 1	Mon.	Classes resume at 8:00 a.m.
December 17	Wed.	Christmas holidays begin at 10:00 p.m.
December 19	Fri.	<i>Deadline for submission of theses in final form to Graduate School by candidates for the master's and doctoral degrees in January, 1970. Last day for taking final oral examinations by candidates for master's degrees not requiring theses.</i>
January 5, 1970	Mon.	Classes resume at 8:00 a.m.
January 14	Wed.	Last day of classes.
January 15	Thurs.	Reading day.
January 16-23	Fri.-Fri.	Final examinations.

SPRING SEMESTER, 1970

January 27	Tues.	Last day to preregister.
January 30- February 1	Fri.-Sun.	Complete registration and pick up class schedules.
February 2	Mon.	First day of classes.
February 6	Fri.	Last day to add a course. <i>Last day for filing application for admission to candidacy for students expecting to complete requirements for the master's degree in May and July, 1970.</i>
February 13	Fri.	Last day to withdraw (or drop a course) with refund; last day to drop a course without a grade.
March 25	Wed.	Easter holidays begin at 10:00 p.m.
March 28	Sat.	Mid-term reports due. <i>Last day for taking qualifying examinations for students expecting to receive doctorate in August, 1970.</i>
March 31	Tues.	Classes resume at 8:00 a.m.
April 23	Thurs.	<i>Deadline for submission of theses in final form to the Graduate School by candidates for the master's and doctoral degrees in May, 1970. Last day for taking final oral examinations by candidates for master's degrees not requiring theses.</i>
May 20	Wed.	Last day of classes.
May 21	Thurs.	Reading day.
May 22-29	Fri.-Fri.	Final examinations.
May 30	Sat.	Commencement.

SUMMER SESSIONS, 1970

First Session

May 28	Thurs.	Last day to preregister.
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June 8	Mon.	Registration and payment of fees; late registration fee for those who register after 1:00 p.m., June 8.
June 9	Tues.	First day of classes.
June 12	Fri.	Last day to register; last day to withdraw (or drop a course) with refund; last day to drop a course without a grade.
June 15	Mon.	<i>Last day for filing application for admission to candidacy for students expecting to complete requirements for the master's degree in August.</i>
June 19	Fri.	<i>Deadline for submission of theses in final form to Graduate School by candidates for the master's and doctoral degrees in July. Last day for taking final oral examinations by candidates for master's degrees not requiring theses.</i>
June 30	Tues.	<i>Last day for taking qualifying examinations for students expecting to receive doctorate in January, 1971.</i>
July 6	Mon.	Holiday
July 16	Thurs.	Last day of classes.
July 17	Fri.	Final examinations.

Second Session

July 9	Thurs.	Last day to preregister.
July 21	Tues.	Registration and payment of fees; late registration fee for those who register after 12:00 noon, July 21.
July 22	Wed.	First day of classes.
July 27	Mon.	Last day to register; last day to withdraw (or drop a course) with refund; last day to drop a course without a grade.
July 31	Fri.	<i>Deadline for submission of theses in final form to Graduate School by candidates for the master's and doctoral degrees in August. Last day for taking final oral examinations by candidates for master's degrees not requiring theses.</i>
August 27	Thurs.	Last day of classes.
August 28	Fri.	Final examinations.

NORTH CAROLINA STATE UNIVERSITY at Raleigh

North Carolina State University is the center for scientific and technological education, research and extension in North Carolina. Created in 1887 by act of the North Carolina legislature as the state's land-grant institution, State was established primarily as a school of agriculture and mechanic arts. In the 80 years since its founding, however, its interests and responsibilities have been greatly broadened in response to the major scientific and technological demands of our rapidly changing world. While maintaining deep commitments to the agricultural and industrial interests of North Carolina, State has become a University of major academic and research dimensions with national and international programs.

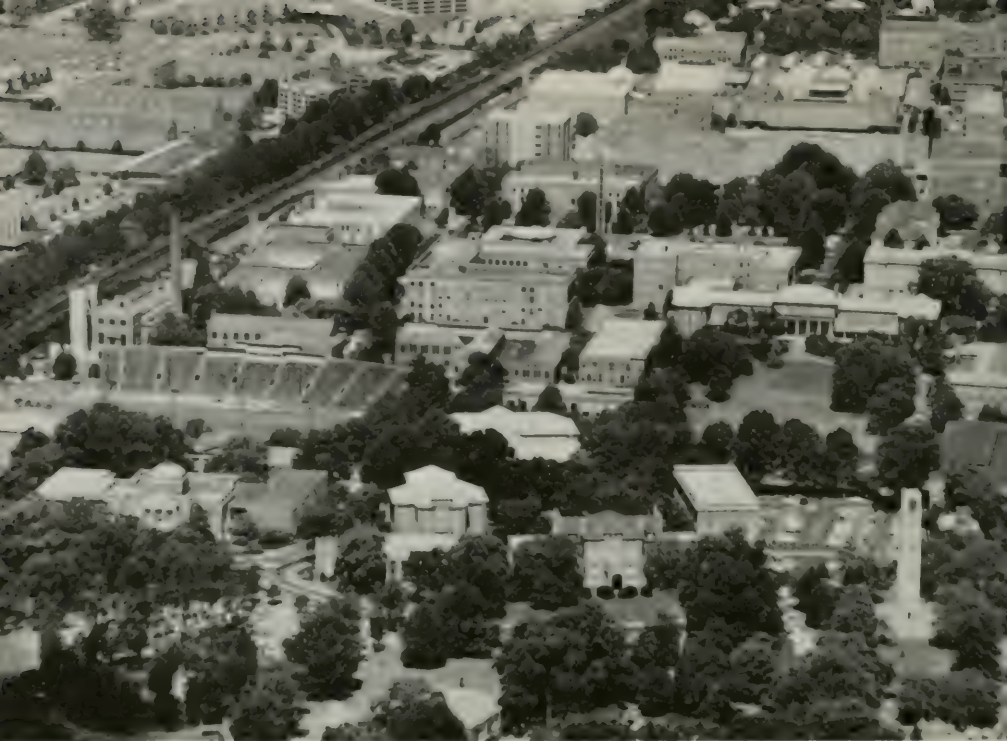
North Carolina State University is one of four institutions comprising the Consolidated University of North Carolina. As a unit of the Consolidated University, North Carolina State fulfills particular responsibilities for specialization. Emphasis at State centers in the areas of agriculture, the biological and physical sciences, engineering, architecture and design, forestry and textiles.

State's organization includes eight undergraduate schools, the Graduate School and the Division of Continuing Education. A total of 75 degrees are offered at the undergraduate level; at the graduate level there are 48 master's and 32 doctoral degree programs offered. Graduate instruction was first offered at North Carolina State in 1893. The first doctoral degree was awarded in 1926.

The eight undergraduate schools at State are the Schools of Agriculture and Life Sciences, Design, Education, Engineering, Forest Resources, Liberal Arts, Physical Sciences and Applied Mathematics, and Textiles. The research, extension and instructional programs of these schools are supported and strengthened by several specialized divisions and offices including: the Institutes of Statistics, Water Resources, Agricultural Policy and Biological Sciences; the Computing Center; the Agricultural and Industrial Extension Services; and the Agricultural Experiment Station with its 17 branch stations. State's facilities also include a minerals laboratory and a fisheries research station.

The North Carolina State campus, with adjoining research farms, covers 3,000 acres and is valued at about \$100 million. There are 80 major University buildings, including classroom, laboratory and auxiliary facilities buildings. In addition to the Raleigh campus, State operates a number of agricultural research farms and extensive experimental forests.

Undergraduate enrollment at State is currently about 8,500; in the fall semester of 1967 the Graduate School enrolled 2,062 students. A large international student group representing 60 countries is presently studying at State.



N. C. State's Academic endeavors and extra-curricular activities take place in the 80 buildings which comprise the main campus.

The University faculty and staff numbers more than 1,500 members, including a graduate faculty of 578.

For 1967-68, State's budget will be about \$50 million. In order to accommodate the growing enrollment and the increasing research requirements, North Carolina State University is pursuing a continuing program of building and acquiring new faculty and research staff. The present research expenditure is about \$15 million annually. Current research appropriations, contracts and grants total more than \$30 million.

State is contributing to international development through an economic and technical mission to Peru, special soils studies programs for Latin America, and cooperative projects with the University of Kabul, Afghanistan and the Institute of Technology at Kharagpur, India. Scores of international visitors, individual faculty work with universities in other countries and the large international student enrollment at State indicate the extent of the University's international involvement.

North Carolina State is accredited by the Southern Association of Colleges and Schools and the North Carolina Association of Colleges and Universities. In addition, individual schools and departments are accredited by various associations in their respective fields. State holds memberships in the Association of State Universities and Land-Grant Colleges, the American Council of Education, the College Entrance Examination Board, the Council of Graduate Schools in the United States, the National Commission on Accrediting, the Oak Ridge Institute of Nuclear Studies, and the Southern Association of Colleges and Schools.

THE GRADUATE SCHOOL of the University of North Carolina

North Carolina State University Division

WILLIAM S. WELLS, *Vice-president for Academic Affairs, Chapel Hill*

WALTER J. PETERSON, *Dean, Raleigh*

The Graduate School of the University of North Carolina is composed of three divisions, one at the University of North Carolina at Chapel Hill, one at the University of North Carolina at Greensboro and one at North Carolina State University at Raleigh. Each branch of the Consolidated Graduate School is administered by a graduate dean who works in close association with the Vice-president in Charge of Academic Affairs. The Graduate Council is composed of representatives of the Administrative Boards of each of the three units of the Consolidated University having a division of the Graduate School. At North Carolina State University the graduate dean is assisted in all matters of policy by an Administrative Board of 11 members. Eight are elected by the faculties of the degree-granting schools and three are appointed by the Chancellor after consultation with the dean.

Graduate instruction at North Carolina State University is organized to provide opportunity and facilities for advanced study and research in the fields of agriculture and life sciences, engineering, forestry, physical sciences and applied mathematics, technological education and textiles. The purpose of these graduate programs is to develop in advanced students a more adequate comprehension of the requirements and responsibilities essential for independent research investigation. In all the graduate programs emphasis is placed upon a high level of scholarship rather than upon the satisfaction of specific course or credit requirements.

The full resources of the Consolidated University of North Carolina are available to all graduate students enrolled at any of the three divisions of the Graduate School. Exceptional facilities for graduate study are provided at North Carolina State University. New buildings furnish modern well-equipped laboratories for graduate study in specialized areas of agriculture and life sciences, engineering, forestry, physical sciences and applied mathematics, and textiles.

The North Carolina Agricultural Experiment Station, the Department of Engineering Research and the Department of Physical Sciences Research are integral parts of the University at Raleigh. The staff, research facilities, equipment and field studies of these organizations contribute

in a very important way to the graduate programs. The Institute of Statistics at North Carolina State makes available to graduate students unusual opportunities in this important phase of research study.

The state of North Carolina, extending from the Atlantic Ocean westward about 500 miles to the Appalachian Mountains, possesses an exceptional range of climatic and topographic environments. The coastal plain, and Piedmont and the mountains provide a rich pattern of agricultural and industrial activity which offer unusual opportunities for research and employment.

North Carolina State University is located in Raleigh, situated on the boundary separating the broad coastal plains on the east from the rolling terrain of the Piedmont on the west, about midway between the northern and southern boundaries of the state. Raleigh is 29 miles from the University of North Carolina at Chapel Hill and 26 miles from Durham, the home of Duke University. The libraries and other facilities of the three institutions make this area one of the important centers of research opportunity in the South.

THE D. H. HILL LIBRARY

The D. H. Hill Library of North Carolina State University has excellent holdings in materials essential for research study in the graduate curricula offered by the University.

As of July 1, 1967, the library held about 400,000 volumes of books and bound journals, including more than 14,000 bound volumes of documents. The books and journals reflect strongly the scientific and technological interests of the University, and the documents represent a most important increment of the whole collection. They include publications of the federal government, all publications of the various Agricultural Experiment Stations, most of the publications of the Engineering Experiment and Engineering Research Stations, and publications of the various research stations all over the world. The library receives over 5,600 current periodicals.

The D. H. Hill Library holdings and other library holdings within a 30-mile radius of North Carolina State constitute the greatest concentration of library resources south of Washington, D. C. These include the D. H. Hill Library, the Chemstrand Research Center Library, the Duke University Library and the Louis Round Wilson Library at the University of North Carolina at Chapel Hill.

An inter-library delivery service exchanges volumes among the three university libraries three days a week. These three libraries have a total of more than three million volumes. This loan service serves faculty and graduate students on the three campuses. Identification certificates enabling participation in the reciprocal arrangement may be secured at the D. H. Hill Library.

A list of scientific periodicals which includes holdings of Duke University and the units of the Consolidated University is available to faculty members and research scientists in the area and to other libraries throughout the nation.

The North Carolina State University library is a depository for all unclassified publications of the federal government that are available for distribution. These include publications of the United States Department of Agriculture, Geological Survey, National Bureau of Standards, Department of Interior and others. Since the library was designed as a depository in 1923, its document holdings in the University's special interest fields are almost 100 percent complete.

The library is a depository for the publications of the Carnegie Institution of Washington and has excellent files of these valuable monographs.

Also, the library is a depository for all unclassified and declassified publications of the Atomic Energy Commission.

Publications of many foreign countries—especially publications dealing with the agricultural sciences and with engineering—are received on exchange by the library.

In July, 1960, the library became a depository for the publications of the Food and Agriculture Administration of the United Nations.

The library, in July, 1959, acquired the Tippmann Collection of Entomology, the outstanding private collection of Dr. Friedrich F. Tippmann of Vienna. The collection contains 6,200 books and bound research journals in the field of entomology, many of them rare and unobtainable.

A recent donation of \$5,000 from the Alumni Association was used to purchase two outstanding sets of the rare 20-volume "Edizione Nazionale" of the works of Galileo and an almost complete file of the important German botanical periodical, "Bibliotheca Botanica," covering the years 1889 to 1960.

Funds from the estate of the late Chancellor J. W. Harrelson have been allocated to purchase rare volumes in mathematics and history of science and important files of research journals.

The research holdings of the library are particularly strong in the fields of entomology, nuclear energy, genetics, aeronautics and space technology, engineering and physics, and include files of the major journals in these fields. A large and useful collection of books in the humanities and the social sciences is available for the use of all undergraduate students as well as the graduate students in these fields.

The library's photocopy service is of great importance to faculty and graduate students in that it provides facilities for copying materials not permitted to leave the library.

The Textiles Library, an on-campus branch of the main library, contains outstanding holdings in textiles and textile chemistry. It is regarded as one of the best textiles libraries in the country. The School of Design Library has a very fine collection of books, journals and slides in the fields of architecture, landscape architecture and product design.

INSTITUTES

AGRICULTURAL POLICY INSTITUTE

The Agricultural Policy Institute was made possible by a grant to North Carolina State University from the W. K. Kellogg Foundation in 1960. The program of the Agricultural Policy Institute consists of activi-

ties directed toward the development and mobilization of information pertaining to the agricultural adjustment problems of the South and analysis and review of alternative policies and programs which might be employed in effecting the necessary adjustments.

The Agricultural Policy Institute centers primary attention on:

1. The kinds of adjustments necessary to bring the returns for resources employed in agriculture to a par with returns for comparable resources employed elsewhere;
2. The processes of adjustment and impediments to improvements in resource use;
3. The effects of alternative public policies and programs on resource allocation and income distribution in the South.

The institute program is an educational program, not a policy-making program. The principal ways by which these objectives are pursued include:

1. Conferences, workshops and seminars;
2. The preparation and dissemination of educational publications;
3. Fellowships and training programs.

All of these activities are undergirded by established research programs at North Carolina State University and other land-grant institutions throughout the nation. Most of the institute's programs are carried forward in active cooperation with other agencies interested in Southern adjustment problems.

INSTITUTE OF BIOLOGICAL SCIENCES

The Institute of Biological Sciences is an organization within the School of Agriculture and Life Sciences of the Departments of Biochemistry, Botany, Entomology, Genetics, Microbiology, Plant Pathology, Zoology and the faculties of biological engineering, biomathematics, cell biology and physiology. Its function is to encourage and promote research and teaching in basic biology and to coordinate interdepartmental activities. Program-type grants are administered by the institute and enable grant support to be provided to discipline and subject matter areas involving faculties in several departments.

Summer institutes are administered by the Institute of Biological Sciences. These have included the National Science Foundation-sponsored Summer Institutes in Genetics and Pesticide Toxicology for College Teachers, Biology for High School Teachers, and Biology, Chemistry, and Mathematics for High School Students. Academic Year Institutes in Biology for High School Teachers have also been sponsored.

The Biological Sciences Undergraduate Curriculum and the Undergraduate Research Participation for Biological Sciences are cooperative programs administered by the institute. These programs have had an outstanding record in the percentage of individuals going into graduate study.

This organization provides a mechanism for strengthening research and instruction in existing graduate programs, and for developing new interdisciplinary areas. Interdepartmental cooperative graduate programs

have become increasingly important within the basic biological sciences and among the biological, physical and engineering sciences. The institute plays an important role in encouraging the full utilization of the faculties and facilities for graduate research and instruction.

INSTITUTE OF STATISTICS

The Institute of Statistics is composed of two sections, one at Raleigh and the other at Chapel Hill. At North Carolina State, the institute provides statistical consulting services to all branches of the institution, sponsors research in statistical theory and methodology, and coordinates the teaching of statistics at the undergraduate and graduate levels. The instructional and other academic functions are performed by the Department of Experimental Statistics, which forms a part of the institute.

The purpose of the institute is to provide extra depth, efficiency and strength in the development and use of modern statistical procedures throughout the University. This involves cooperative efforts with many schools, departments and agencies. The establishment of a nationally recognized program in quantitative genetics and continuing developments in the field of biomathematics illustrate the coordinating role the institute plays in the quantitative sciences.

In addition to these local activities, the institute maintains close and continuing contact with statistics scholars, research programs and graduate instruction programs throughout the world. It has helped develop an international abstracting journal for statistical articles. The institute is the point of contact for grants and contracts in statistics. It has been active in organizing and maintaining a strong Southern Regional Cooperative Graduate Summer Session in statistics. Approximately 15 graduate assistantships in statistics are made available annually through the efforts of the institute. All of these contributions have added substantially to the vigor of the entire graduate program of North Carolina State University.

WATER RESOURCES RESEARCH INSTITUTE

The Water Resources Research Institute is a unit of the Consolidated University of North Carolina, located on the campus of North Carolina State University at Raleigh. The deans of the Graduate School, School of Engineering, and School of Agriculture and Life Sciences at North Carolina State University and two faculty members from the University of North Carolina at Chapel Hill serve as a board of directors. Faculty members from the Raleigh and Chapel Hill campuses serve on the technical committee and participate in its research and educational programs. The institute was established to promote a multi-disciplinary attack on water problems, to develop and support research in response to the needs of North Carolina, to encourage strengthened educational programs in water resources, to coordinate research and educational programs dealing with water resources, and to provide a link between the state and federal water resources agencies and related interests in the University.

Research and educational activities are conducted through established departments and schools of the University. All senior colleges and universities of North Carolina are eligible to participate in the institute's research program. Applications for research grants must be received by December 1 preceding the fiscal year for which funds are requested. Basic support for the institute's program is provided by the Office of Water Resources Research, U. S. Department of the Interior, under the Water Resources Research Act of 1964.

The institute has sponsored a graduate minor in water resources which offers a strong water resources program with the major in any of the basic disciplines contributing to water resources planning, conservation, development and management. This capitalizes on the combined training resources of the Chapel Hill and Raleigh campuses of the University and offers these in an organized way to graduate students seeking interdisciplinary training in this important field. Additional information concerning the program is presented elsewhere in this catalog.

The institute also sponsors research and educational symposia and seminars, encourages the development of specialized training opportunities, and provides a means for the continuing evaluation and strengthening of the University's total water resources program.

SPECIAL LABORATORIES AND FACILITIES

COMPUTING FACILITIES

There has recently been a complete changeover of the equipment in the Computing Center, and of the computing organization in the Research Triangle area. Duke University, the University of North Carolina at Chapel Hill and North Carolina State University have joined together to form the Triangle Universities Computation Center (TUCC). This center, equipped with a large computer (IBM System 360, Model 75), is located in the Research Triangle Park. Each campus is equipped with a high-speed computer-terminal, and several intermediate and low-speed units. In the case of North Carolina State University, an IBM System 360, Model 40 (512K with a 2314 disc system) is located in the Computing Center, and operates simultaneously as a high-speed teleprocessing terminal and a stand-alone computer. In addition, the Computing Center supports two medium-speed computer-terminals (IBM 1130); one in the School of Engineering and the other in the School of Physical Sciences and Applied Mathematics. Other low-speed terminals (IBM 1050, and teletypes) are located in departments and projects on the campus. In addition, analog and analog-digital equipment is available on the campus.

One of the principal reasons for expansion to the above computer configuration was to take care of the heavy graduate student training and research requirements on the campus. The present computer system provides for a wide range of computing needs in graduate training and research. Programming courses of both the regular credit type, as well as short courses, are offered by the Department of Computer Science and the Computing Center personnel.

NUCLEAR SERVICE FACILITIES

Specialized nuclear service facilities are available to the University faculty and students, and industry for teaching, research and services. The purpose of these facilities is to further the use of nuclear energy in engineering and scientific programs. The facilities include: a 10-kilowatt reactor with a variety of testing facilities; a 26,000-curie Cobalt 60 gamma irradiation source with controlled environment; intermediate hot laboratories with hoods, junior caves and glove boxes; activation analysis laboratory with solid-state detectors; counting and photographic rooms; and pulsed neutron source. Future facilities under design are a one-megawatt steady state and pulse type reactor (PULSTAR), and 50,000 square foot Nuclear Science and Engineering Research Center.

PESTICIDE RESIDUE RESEARCH LABORATORY

The Pesticide Residue Research Laboratory is a facility in the School of Agriculture and Life Sciences devoted to research on pesticide residues in animals, plants, soils, water and other entities of the environment of man. The laboratory is located in the Department of Entomology but also serves the Departments of Crop Science, Plant Pathology, Horticultural Science, Soil Science, Animal Science, Poultry Science and Zoology on research projects requiring assistance on pesticide residue analyses.

The laboratory functions as a focal point for residue research involving interdepartmental cooperation, but faculty in the laboratory also conduct separate research of their own interest on persistence and decomposition of pesticides in soils and plants, absorption and translocation in plants, distribution in the environment, and contamination of streams, estuaries and ground water.

The modern laboratory is equipped with the latest analytical instruments. Graduate study can be undertaken in any aspect of pesticide residues either in the Pesticide Residue Research Laboratory or in one of the cooperating departments.

REPRODUCTIVE PHYSIOLOGY RESEARCH LABORATORY

The Reproductive Physiology Research Laboratory, Department of Animal Science, includes four environmental control rooms designed to provide constant levels of air temperature, humidity and light for animals involved in studies on reproduction. Facilities and equipment are available for surgery, *in vitro* growth of embryos, isotope labeling in embryo metabolism or transfer of embryos between females.

Support for research at both the master's and the doctoral levels is available. Students may elect to take a comparative approach to a specific problem in mammalian reproduction, working with several species, or they may choose to work with a single species. Generally students select a problem associated with the identification of factors influencing early prenatal development, the endocrine control of ovarian function or some aspect of elucidation and control of aberrations in mammalian reproduction.

Students whose work is concentrated in reproductive physiology major in either animal science or physiology with a minor in related disciplines.

SOUTHEASTERN PLANT ENVIRONMENT LABORATORIES

The Southeastern Plant Environment Laboratories operate as a cooperative association between North Carolina State and Duke University with one unit, commonly called a phytotron, located on each campus. The laboratory is especially designed for research dealing with the response of biological organisms to their environment, and the high degree of control makes it possible to duplicate any climate from tropical rain forest to arid desert or arctic cold.

Research in the North Carolina State unit concentrates on problems encountered in the agriculture of the southeastern United States. However, the ability to control all phases of the environment allows inclusion of research dealing with space, pollution and tropical agriculture as well as basic physiological and biochemical investigations.

The facilities are available to the resident research staff, participants in North Carolina State's graduate research program and to domestic and foreign visiting scientists.

SPECIAL TRAINING PROGRAMS

CELL BIOLOGY PROGRAM

Many present-day biologists seek a basic understanding of biological phenomena at the cellular and subcellular or molecular level. They recognize that principles and concepts developed in one system may apply to the cells of many varieties of organisms and may help to explain the more complicated activities of more highly organized systems such as organs and tissues, individuals and populations. These biologists need not only a thorough training in one or more of the traditional disciplines, but also need a broader training than might be provided by the customary major and minor.

North Carolina State University provides a program of training for this through an interdisciplinary minor. Students major in one of the many graduate programs in the area of biology, but select a thesis problem that involves research at the cellular or subcellular level. The program of study includes a combination of required and elective courses to provide an appropriate minor program in cell biology. The core courses that are required for this minor and the list of suitable elective courses are determined by a cell biology committee.

MOLECULAR TOXICOLOGY AND COMPARATIVE BIOCHEMISTRY PROGRAM

Increasing concern for environmental contamination has stimulated interest at the state, federal and international levels to support basic training which will interest students in careers directed toward an understanding of the significance of chemicals introduced into our environ-

ment, both directly and indirectly—agricultural chemicals, food additives, industrial wastes, etc. An interdisciplinary program in molecular toxicology and comparative biochemistry is available to graduate students whose interests are directed toward an explanation of the effects of toxicants at the molecular and cellular levels.

Students select majors and or minors from the following programs: biochemistry, cell biology, entomology, experimental statistics, genetics, physiology and plant physiology. A core course in Fundamentals of Molecular Toxicology and a seminar series orient the students to the basic research problems and serve to coordinate the program. Assistantships and fellowships are available from P.H.S., N.S.F. and N.D.E.A.

NUTRITION PROGRAM

The nutrition advisory committee for the School of Agriculture and Life Sciences is an organization composed of graduate faculty who are participating in nutritional teaching and research in the Departments of Animal Science, Biochemistry, Food Science, Poultry Science and Extension Home Economics. The objective of this organization is to develop an interdepartmental graduate program. Lecture and laboratory courses are provided to train graduate students in the fundamental aspects of nutrition. The minor phase of the graduate program may be obtained in the basic disciplines of biochemistry, physiology, biostatistics and microbiology as well as in the represented departments. Financial assistance is available for qualified students.

RESEARCH PROGRAM AT THE OAK RIDGE ASSOCIATED UNIVERSITIES

North Carolina State is one of the sponsoring institutions of the Oak Ridge Associated Universities at Oak Ridge, Tennessee. Through this cooperative association, North Carolina State's graduate research program has at its disposal the facilities and research staff at Oak Ridge National Laboratory. Extensive research programs are under way there on physical and biological effects of radiation, radioisotope utilization and many other areas of nuclear science and engineering. When master's and doctoral candidates have completed their resident work, it may be possible, by special arrangement, for them to do their thesis research at Oak Ridge. In addition, it is possible for the staff members of this University to go to Oak Ridge for advanced study in their particular fields.

GRADUATE INSTITUTE OF EXTENSION EDUCATION

The Graduate Institute of Extension Education provides an interdisciplinary program by drawing together basic concepts from the behavioral sciences and education relevant to adult and extension education. The institute is available on campus to serve instructional needs as well as the need for basic and applied research in the field.

The institute is administered by a five-man board of directors including: the dean of the Graduate School; deans of the Schools of Agriculture

and Life Sciences, Education and Liberal Arts at North Carolina State; and the dean of the School of Home Economics at the University of North Carolina at Greensboro. Supplementing the efforts of the board of directors is an advisory committee representing the eight departments involved in this interdisciplinary instructional and research program.

A number of active research projects in the area of radiation are under way by the Department of Physics at North Carolina State University.



GENERAL INFORMATION

ADMISSIONS

Graduate School admission may be to full, provisional or unclassified status. Applications for admission to the Graduate School must be accompanied by official transcripts from all colleges previously attended.

FULL GRADUATE STANDING

For admission in this category a student must have a bachelor's degree from a recognized college or university regarded as standard by a regional or general accrediting agency, and must have at least a "B" grade average in his undergraduate major.

PROVISIONAL ADMISSION

Provisional admission may be granted to applicants who lack undergraduate work considered essential for graduate study in the major field. Course work, without graduate credit, will be required to make up such deficiencies before admission to full graduate status can be granted.

Graduates from nonaccredited institutions may be granted **provisional admission** when their academic records warrant this status. Additional course work will be required of such students when deficiencies in their previous training are apparent.

Graduates from accredited institutions whose scholastic records are below the standards for admission to full graduate standing may be admitted provisionally when unavoidable extenuating circumstances affected their undergraduate averages or when progressive improvement in their undergraduate programs warrant provisional admission. All such students are required to take the Graduate Record Examination and to submit scores to the Graduate School office in support of their application.* The National Teacher Examination may be substituted for the Graduate Record Examination if recommended by the department head. Information as to the dates on which the Graduate Record and the National Teacher Examinations are given may be obtained at the Graduate School office.

Graduate students admitted to provisional status may attain full graduate standing when the deficiencies responsible for their provisional status are corrected. They also must have maintained a satisfactory academic record in all course work taken as part of their graduate program. Change from provisional to full graduate standing is effected only on written

* Most of the advanced degree-granting departments in the University strongly encourage submission of Graduate Record Examination scores. The following departments will *not* act on an application unless it is accompanied by GRE scores: biomathematics, English, history, mathematics, politics, psychology and zoology.

recommendation from the department in which the student is seeking his degree.

UNCLASSIFIED GRADUATE STUDENTS

Unclassified graduate students are not candidates for graduate degrees. They may take courses for graduate credit but may not apply more than 10 credits earned while in the unclassified status to any program leading to an advanced degree at this institution. Unclassified graduate students are expected to meet the same admissions requirements that apply to graduate students in full standing.

Applications for admission to the Graduate School should be on file in the Graduate School office at least 30 days in advance of the registration date for the term in which the student wishes to enroll in the Graduate School.

Public school personnel (primary teachers, secondary teachers or administrators) registering at North Carolina State for the first time who are interested primarily in "Certification Credit" may enroll as graduate students for a maximum of six semester hours without forwarding official transcripts of previous work to the Graduate Office. If, however, application is not made through normal channels for graduate credit in the session in which the course or courses are taken, the student will not be permitted to apply the credit toward an advanced degree at North Carolina State, or elsewhere.

In all cases where the teacher's interest is primarily in approval for certification credit, the School of Education will be responsible for assessing the adequacy of the teacher's qualifications for enrollment in the University in the particular course or courses. The School of Education will also be responsible for advising all such students early in each school session that if they wish their credits to be applied in due course to a higher degree at North Carolina State, or elsewhere, normal admission procedures will be required.

All teachers who have previously attended North Carolina State University and earned six semester hours of credit and wish to enroll for additional courses for graduate credit will be required to make application for admission to the Graduate School in the usual manner, if they have not already done so.

In all cases a "B" level of academic performance or better is required.

GRADUATE-SPECIAL

This classification is used primarily for students enrolling in special institutes such as the summer institutes regularly held for college teachers, high school teachers and graduate students, or special graduate training programs for separate groups such as our summer offerings for extension staff.

The following rules apply to students registered as graduate-special:

1. All must have at least a baccalaureate degree from an accredited institution of higher learning;
2. Official transcripts need not be submitted to the Graduate Office for enrollment in this classification but the appropriate institute or pro-

gram director must file with the graduate dean well in advance the nature of the program, the criteria and methods used in selection of the students, and assurances that the students have adequate preparation for the course contemplated;

3. Placement in this classification carries with it no implication that students will be admitted to the Graduate School in any of the other classifications;
4. Graduate credit will be allowed, not to exceed six hours of course work at the 500 or 600 level;
5. If the student is in due course admitted to the Graduate School, graduate credit obtained under this classification may apply to an advanced degree, if in the judgment of the advisory committee the course(s) is germane to the particular program of work, and performance was at an adequate level;
6. Students who have received as much as six hours of graduate credit under this classification must make application for admission to the Graduate School before permission will be granted to enroll for additional graduate work.

REGISTRATION

The Office of Registration must have written authorization from the dean of the Graduate School before any graduate student will be given a permit to register. This authorization will be sent to the Office of Registration by the graduate dean at the time the student is notified of his acceptance.

REGISTRATION FOR COURSES IN OTHER BRANCHES OF THE UNIVERSITY

Graduate students working toward an advanced degree at North Carolina State University may find it desirable to enroll for certain courses in one of the other branches of the University. The following principles and procedures apply in such cases:

1. A graduate student shall be considered to remain in the Graduate School of the branch of the University to which he is admitted for a specific degree program, to be under the control of his department, to be advised by his department and to be enrolled by that Graduate School for any graduate work which he may take for credit in his own branch or any other branch of the University.
2. A graduate student at one branch of the University who is taking work at some other branch of the University for credit toward his degree at the University branch to which he has been admitted shall be enrolled for all courses, including those at the other branch of the University, in his home Graduate School. This Graduate School shall consider courses taken at the other branch of the University as a part of the student's normal load and shall use such enrollment in computing the total billing which the home University will make to the student.

3. A student at one branch of the University who is by this method enrolled in one or more graduate courses at some other branch of the University will be admitted to these courses, provided space exists in these classes, by the Graduate School of the other branch upon normal notification by the Graduate School of the student's branch that the student has been properly enrolled for these courses and has the approval of the home branch for this program of study.
4. During the summer sessions, approval of the courses to be taken shall be asked, but the billing procedures shall be those regularly used for visiting students.
5. No student enrolled as a regular graduate student in any branch of the University shall be admitted to courses at another branch of the University without the presentation by the student of written permission from the Graduate School of the branch to which the student was originally admitted.

PHYSICAL EXAMINATIONS

All regularly enrolled graduate students must take a physical examination preferably given by the family physician and the results recorded on forms provided by the University. When this is not done the examination may be given by the North Carolina State physician during registration for a fee of \$10.

COURSE LOAD

A full-time graduate load is considered to be nine to 15 credits per semester. This course load restriction is made so that graduate students may have time for reading and contemplation well beyond the limits set for satisfactory undergraduate work. In exceptional cases one or two additional credit hours may be added to the roster if necessary in order to get prerequisite work not taught in subsequent terms, provided the corresponding adjustment in course load is made in the other terms. Rosters with additional credit hours beyond 15 should be accompanied by a special note from the head of the major department indicating the reasons for the additional work.

Full-time faculty of instructor rank and above and other full-time employees of the University who hold membership in the Teachers' and State Employees' Retirement System may register for credit or audit one course in each semester and one course during one of the two summer sessions with free tuition privileges. Free tuition privileges apply only during the period of one's normal employment and do not include such other charges as registration, laboratory or other appropriate fees. Each applicant for free tuition privileges must complete and submit through regular administrative channels a form provided by the University. A maximum of eight semester hours may be taken during the academic year.

Employees having academic rank higher than that of instructor may register for graduate work for credit to be transferred to other institutions. They may not undertake programs for graduate degrees at the Consolidated University of North Carolina.

Graduate assistants on half-time appointments are permitted a maximum course load of nine credits per semester unless corresponding adjustments are made in their service obligations during the same semester. If the appointment is for the academic year of nine months, half-time assistants are restricted to a maximum of 18 credit hours of work during the nine months of their appointment. Half-time graduate assistants whose appointments are for 12 months may not exceed a total of 24 credits during the 12-month period of their appointment. Three-quarter time graduate assistants whose appointments are for 12 months may register for a total of 16 credits during the calendar year. A total of six credits is the maximum load in a regular semester.

A member of the North Carolina State senior class may, upon approval of the dean of the Graduate School, register for courses in the 500 group for graduate credit to fill a roster of studies not to exceed 15 credits in any semester. No more than six hours of graduate credit may be acquired by an undergraduate student. Courses listed with numbers in the 600 series are not ordinarily open to undergraduates. Occasional exceptions may be made for "honors" students.

TUITION AND FEES

Tuition rates for students enrolled in the Graduate School at North Carolina State are as follows:

North Carolina Resident—\$9 per semester hour of enrollment up to and including nine semester hours; for 10 semester hours or more, \$87.50 for the semester;

Nonresident—\$37.50 per semester hour for each semester hour of enrollment up to and including nine semester hours; for 10 semester hours or more, \$350 for the semester.

Incidental fees and charges are levied for purposes and services available to all graduate students whether or not the student takes advantage of them.

The full amount of incidental fees and charges will be collected, notwithstanding the number of semester hours of credit for which the student may enroll.

For the academic year 1967-68, fees are as follows:

First semester	\$89.50
Second semester	\$88.50

In cases of occasional or part-time graduate students not in residence, application for cancellation of nonacademic fees may be made if it is clear that the student could not use the services covered. Application forms are available in the Graduate School and the Office of Business Affairs.

Full-time faculty of instructor rank and above and other full-time employees of the University who hold membership in the Teachers' and State Employees' Retirement System may register for credit or audit one course in each semester or one course during one of the two summer terms with

free tuition privileges. Free tuition privileges apply only during the period of one's normal employment and do not include such other charges as registration, laboratory or other appropriate fees. Each applicant for free tuition privileges must complete and submit through regular administrative channels a form provided by the University. A maximum of eight semester hours may be taken during the academic year.

Faculty members on less than full-time appointments will be permitted to take more than one course per semester upon the recommendation of their dean and the approval of both the dean of the Graduate School and the Provost. In these cases tuition and fees will be the same as those for part-time graduate students computed at residence rates.

Maximum permissible course loads for graduate students holding part-time appointments are as follows: three-quarters time, six hours; half-time, nine hours; quarter-time, 12 hours.

Students wishing to visit classes without participation in class discussions, quizzes or examinations must register for this privilege as auditors. *Visiting classes without registration is not permitted.* Graduate students may register for one course as an audit in any semester without charge when the audit is certified by the dean of the Graduate School as a part of course work for which tuition charges are made (this does not apply in the summer sessions).

Graduate students often mistakenly assume that registration for an audit carries with it the privilege of irregular or infrequent attendance. This is not correct! When audits are recommended by departmental advisors or appear on the student's plan of work, regular attendance is expected as in courses taken for credit. Failure to attend on a regular basis will be so noted on the student's permanent record.

Audits in subjects in which the student has had no previous experience will be evaluated at full credit value in determining course loads. Audits taken as repetition of work previously accomplished are considered at one-half their credit value in calculating course loads. With the single exception of foreign language audits, all audit registrations must fall within the maximum permissible course loads. Audits are not permitted students registering for thesis preparation. While audit registrations are evaluated for purposes of determining permissive course loads in terms of the above regulations of the Graduate School, the Office of Business Affairs considers all audits, excepting the one permitted free of charge, in terms of full credit value in calculating the tuition for graduate students.

All graduate students holding appointments of one-third service obligation or more and receiving a regular monthly salary check are charged the resident or "in-state" rate of tuition.

Graduate students who have completed all course work, research and residence requirements and who are in residence for the purpose of writing a thesis or dissertation may register for "thesis preparation." The tuition charge for this registration is \$15. Students registering for thesis preparation will pay, in addition, fees of \$89.50 in the fall semester and \$88.50 in the spring semester. When not in residence these charges will be \$15 plus \$7 registration fee or \$22.

Graduate students in master's programs not requiring a thesis, who have

completed all requirements except the final oral examination by the beginning of the semester in which the degree is to be awarded, will be required to register for "examination only." The tuition charge for this registration is \$8. Students registering for examination only will pay, in addition, fees of \$89.50 in the fall semester and \$88.50 in the spring semester. When not in residence these charges will be \$8 plus \$7 registration fee, or \$15.

Graduate students not in residence who have completed all requirements for the degree sought, including the final examination and submission of the thesis in final form to the Graduate School, will be required to register for "degree only" in the semester in which the degree is awarded. The charge for this registration is \$10.

A diploma fee of \$12 is charged all students receiving a master's degree and a fee of \$17 is charged all students who receive a doctorate. A fee of \$21 is charged all doctoral candidates for microfilming their dissertations.

Anyone who feels a mistake has been made in his bill may discuss the matter with the Office of Business Affairs. Any further appeals should be made to the Committee on Refund of Fees. Forms for this appeal may be obtained from the Office of Business Affairs.

All tuition charges and fees are subject to change without notice.

FEES FOR SUMMER SCHOOL

Registration Fee	\$23.50
Tuition (in-state students per credit hour)	\$ 7.50
Tuition (out-of-state students per credit hour)	\$21.00
Audits (per credit hour)	\$ 7.50

RESIDENCE STATUS

General: The tuition charge for legal residents of North Carolina is less than for nonresidents. To qualify for in-state tuition, a legal resident must have maintained his domicile in North Carolina for at least the six months next preceding the date of first enrollment or reenrollment in an institution of higher education in this State.

Minors: The legal residence of a person under 21 years of age at the time of his first enrollment in an institution of higher education in this State is that of his parents, surviving parent, or legal guardian. In cases where parents are divorced or legally separated, the legal residence of the father will control unless custody of the minor has been awarded by court order to the mother or to a legal guardian other than a parent. No claim of residence in North Carolina based upon residence of a guardian in North Carolina will be considered if either parent is living unless the action of the court appointing the guardian antedates the student's first enrollment in a North Carolina institution of higher education by at least 12 months.

A minor student whose parents move their legal residence from North Carolina to a location outside the State shall be considered to be a nonresident after six months from the date of removal from the State.

For the purpose of determining residence requirements under these rules, a person will be considered a minor until he has reached his 21st birthday. Married minors, however, are entitled to establish and maintain their residence in the same manner as adults. Attendance at an institution of higher education as a student cannot be counted as fulfilling the six-month domicile requirement.

Adults: A person 21 years of age or older is eligible for in-state tuition if he has maintained continuous domicile in North Carolina for the six months next preceding the date of enrollment or reenrollment, exclusive of any time spent in attendance at any institution of higher education. An in-state student reaching the age of 21 is not required to reestablish residence provided that he maintains his domicile in North Carolina.

Married Students: The legal residence of a wife follows that of her husband, except that a woman currently enrolled as an in-state student in an institution of higher education may continue as a resident even though she marries a nonresident. If the husband is a nonresident and separation or divorce occurs, the woman may qualify for in-state tuition after establishing her domicile in North Carolina for at least six months under the same conditions as she could if she were single.

Military Personnel: No person shall be presumed to have gained or lost in-state residence status in North Carolina while serving in the Armed Forces. However, a member of the Armed Forces may obtain in-state residence status for himself, his spouse, or his children after maintaining his domicile in North Carolina for at least the six months next preceding his or their enrollment or reenrollment in an institution of higher education in this State.

Aliens: Aliens lawfully admitted to the United States for permanent residence may establish North Carolina residence in the same manner as any other nonresident.

Property and Taxes: Ownership of property in or payment of taxes to the State of North Carolina apart from legal residence will not qualify one for the in-state tuition rate.

Change of Status: The residence status of any student is determined as of the time of his first enrollment in an institution of higher education in North Carolina and may not thereafter be changed except: (a) in the case of a nonresident student at the time of his first enrollment who, or if a minor his parents, has subsequently maintained a legal residence in North Carolina for at least six months, and (b) in the case of a resident who has abandoned his legal residence in North Carolina for a minimum period of six months. In either case, the appropriate tuition rate will become effective at the beginning of the term following the six-month period.

Responsibility of Student: Any student or prospective student in doubt concerning his residence status must bear the responsibility for secur-

ing a ruling by stating his case in writing to the admissions officer. The student who, due to subsequent events, becomes eligible for a change in classification, whether from out-of-state to in-state or the reverse, has the responsibility of immediately informing the Office of Admissions of this circumstance in writing. Failure to give complete and correct information regarding residence constitutes grounds for disciplinary action.

Adjustments: Discretion to adjust individual cases within the spirit of these regulations is lodged in the Vice-president and Finance Officer of the University.

FELLOWSHIPS AND GRADUATE ASSISTANTSHIPS

FELLOWSHIPS

Graduate fellowships and traineeships provide funds to graduate students to assist in the support of their programs of advanced study. Holders of fellowships have no service obligation to the University and may devote full time to their graduate programs.

Some of the agencies sponsoring fellowships at North Carolina State University are the Aluminum Company of America, the Atomic Energy Commission, Chemstrand, Douglas Aircraft Company, Dow Chemical Company, DuPont Company, E. Sigurd Johnson, Eastman Kodak Company, Ford Foundation, General Electric, General Food Corporation, Honor Society of Phi Kappa Phi, Kellogg, National Aeronautics and Space Administration, National Institutes of Health, National Lumber Manufacturing Association, National Science Foundation, North Carolina Grange (E. G. Moss Fellowship), North Carolina Textile Foundation, Office of Education (Department of Health, Education, and Welfare), Public Health Service (U. S.), R. J. Reynolds Tobacco Company, Research Corporation, Rockefeller Foundation, Scholler Foundation, Shell Oil Company and Wachovia Bank and Trust Company.

Information relative to stipends, areas of research study supported by specific fellowships, and application forms may be obtained from the Graduate School or from the heads of the appropriate departments.

ASSISTANTSHIPS

Graduate assistantships are granted to selected students who normally devote half-time to service duties for the University. Teaching assistantships carry stipends ranging from \$2,700 to \$3,600 for the academic year and permit the holder to enroll for 60 percent of a full course load. The stipends for research assistantships range from \$2,700 to \$3,600 for a calendar year appointment.

The University offers 717 assistantships requiring a service obligation in either teaching or research. Some of these are supported by funds granted by the following agencies: the Air Force Cambridge Research Laboratories, Air Force Office of Scientific Research, the American Museum of Natural History, American Potash Institute, Army Missile Com-

mand, Army Research Office (Durham), the Atomic Energy Commission, Best Foods, Bureau of Commercial Fisheries, Campbell Soup Company, the Chilean Nitrate Education Bureau, Inc., Gerber Products Company, Graham Manufacturing Company, Hercules Powder Company, Department of Labor, the Lilliston Implement Company, the Lilly Company, National Aeronautics and Space Administration, National Cotton Council, National Institutes of Health, National Science Foundation, North Carolina Agricultural Foundation, North Carolina Dairy Foundation, North Carolina Milk Commission, North Carolina Motor Carriers Association, Pacific Coast Borax Company, Peanut Growers Association, the Petroleum Research Fund of the American Chemical Society, Pulp and Paper Foundation, Inc., R. J. Reynolds Tobacco Company, the Ralston-Purina Company, the Solvay Process Division of the Allied Chemical Company, Southeastern Association of Game and Fish Commissions, the Tennessee Corporation, U. S. Department of the Interior, U. S. Office of Education, U. S. Public Health Service and the Weyerhaeuser Foundation.

Students interested in applying for a fellowship or assistantship may indicate their interest on the application forms submitted.

OTHER FINANCIAL AID

LONG-TERM, LOW-INTEREST LOANS

Graduate students who are American citizens are eligible for consideration for long-term, low-interest loans. Applications are made to the Financial Aid Office, 205 Peele Hall. To qualify, a student must demonstrate clear financial need and must be making satisfactory progress academically.

National Defense Student Loans: Graduate students may qualify for up to \$2,500 per year in loans from this source, with a cumulative maximum of \$10,000. Interest at three percent begins to accrue and repayment of principal begins nine months after the student's last enrollment for at least half-time college study. Repayment may be extended over a 10-year period. For the most part, long-term loans are approved as supplementary to fellowships and assistantships. A student is expected to accept an assistantship if one is available, before seeking loan help.

Federal Guaranteed Loan Program: This program provides for loans from private lenders, with interest paid by the federal government in cases of medium or small family income. Graduate students may borrow up to \$1,500 per year with an aggregate limit of \$7,500. Application procedures differ with state of residence. A North Carolina resident obtains forms at the financial aid office of the institution which he is attending and submits them through the financial aid office to the College Foundation, Inc., which acts as the agency for all private lenders in North Carolina who participate.

COLLEGE WORK-STUDY PROGRAM

Work-study jobs under a federal program are available to graduate students as well as undergraduates. Again, however, the graduate student is expected to accept an assistantship in preference if one is available. The same application procedure and eligibility requirements are in effect as in the case with National Defense and institutional long-term loans. In fact, consideration for both or either kind of financial aid is obtained by one application. Available jobs are normally on campus. The student is limited to 15 hours per week while attending classes and to 40 hours per week during vacation periods. Rates of pay vary; each job awarded is given an approximate dollar value. Usually a work-study job is offered as alternative to a long-term loan of like value.

SHORT-TERM EMERGENCY LOANS

Usually in amounts of \$50 or less, loans to be repaid within 30 to 60 days may be obtained on short notice at the Financial Aid Office. Students are asked to limit such requests to actual emergency situations where alternative sources of funds are unavailable.

HOUSING

North Carolina State University strives to provide suitable accommodations in which students may live in an atmosphere conducive to the pursuit of academic excellence and personal development. This includes the provision of comfortable physical facilities, appropriate recreational activities and competent resident supervision. The University operates 14 residence halls for 5,133 men, two residence halls for 558 women, 300 apartments for married students and 12 on-campus fraternity houses for 480 men. A residence hall complex consisting of three buildings, which will accommodate 1,100 men or women students, is now under construction and will be open in the spring of 1968.

RESIDENCE HALLS

Students are assigned to the residence hall of their choice, insofar as possible, regardless of their classification or curriculum. Residence halls are supervised by staffs appointed by the Student Housing Office. These staffs are to aid residents in their personal development and adjustment, to develop and maintain suitable conditions for study, rest and meaningful group living experiences, and to encourage high academic achievement. These staffs have overall responsibility for the operation and conditions in the residence halls.

HOUSING FOR MARRIED STUDENTS

Three hundred University-owned apartments in McKimmon Village are available for married students. Privately owned apartments and houses available for rent to University students are listed in the Housing Rental

Office in Leazar Hall. University-owned efficiency, one- and two-bedroom units rent for \$45, \$59.50 and \$71 per month, respectively. These rental fees do not include utilities except water. Information may be obtained on University-owned apartments by writing to the Housing Rental Office, Box 5505, North Carolina State University, Raleigh, N. C., 27607. The University does not operate a trailer parking area; however, privately owned parks are available within a reasonable distance of the campus.

ROOM RESERVATIONS

Rooms in residence halls are reserved in the order in which applications are received as long as space is available. Full payment of the semester rent is required to reserve a room. Roommate preferences will be honored if possible, provided both applicants make written requests and send their payments in the same envelope to the Office of Business Affairs. If no roommate preference is indicated, students enrolled in a similar curriculum and of the same classification are assigned together, if possible.

ROOM RENTALS

Rooms in the men's residence halls rent for \$133 per semester and in the women's halls \$158 per semester. Rent is payable prior to the beginning of each semester as announced by the Housing Rental Office. Students assigned rooms during the fall semester may leave personal belongings in the rooms between semesters provided they reserve the room for the spring semester. Rooms not reserved for the spring semester must be completely vacated and the keys turned in to the Housing Rental Office at the end of the fall semester.

REFUND OF ROOM RENT

If a reservation is cancelled at the Housing Rental Office, Leazar Hall, in person or in writing at least seven days prior to the first day of classes (date of cancellation is date notification is received at that office), the rent paid will be refunded less a \$25 reservation fee. After this date, no refund will be made for any reason other than failure to register or official withdrawal from the University. If a reservation is cancelled for these reasons, the rent paid will be refunded less a \$25 reservation fee or a daily charge of \$2 for men and \$2.25 for women from the seventh day preceding the first day of classes to the date of cancellation, whichever amount is greater. If a student fails to check in and secure his keys on or before the first day of classes, his reservation will be subject to cancellation and no refund will be made except as stated above.

FURNISHINGS AVAILABLE

Rooms are furnished with beds, mattresses, chairs, study tables, dressers and closets. The student must bring his own study lamp if not assigned to Bragaw, Lee or Sullivan Halls. Janitorial service is supplied by the University. Linen, blankets and pillows are available through the

linen rental service operated by the Auxiliary Services Office. Laundry rooms with washers and dryers are located in the women's residence halls.

The residence halls are not equipped with kitchen facilities for meal preparation.

FOOD SERVICES

Food service is provided at three conveniently located facilities—Erdahl-Cloyd Union, Leazar Cafeteria and Harris Cafeteria. Cost depends on the individual's requirements and the selection of food. A typical student, paying cash for each meal, will spend \$400 to \$500 per academic year.

The Students Supply Stores operates soda fountain snack bars for the convenience of resident students in five areas. There is an additional snack bar located in the Nelson Textile Building.

LINEN RENTAL SERVICE

The linen service provides for the initial issue of two sheets, one pillow case and three towels. The student may exchange his linen weekly at a cost of \$20 per year. Pillows may be rented for \$1.50 per year. A regular blanket rents for \$3 per year, and the N. C. State monogrammed blanket rents for \$5. These services are available to both campus and off-campus students. Application may be made in the Auxiliary Services Office in Holaday Hall.



The School of Agriculture and Life Sciences conducts complex research endeavors in many fields of study accounting for a large portion of the \$15 million annual research expenditure of the University.

GRADUATE DEGREES

Admission to the Graduate School does not constitute admission to candidacy for a graduate degree. Application for admission to candidacy for graduate degrees must be submitted to the Administrative Board of the Graduate School. Applications of students preparing for the master's degree may not be filed before the satisfactory completion of one full semester of graduate study and must be presented before the end of the first week of the last semester in residence. Approval of the application will be determined by the quality of the scholastic record and on the certification by the major department that the student is qualified to continue advanced work. Admission to candidacy for the doctorate is granted upon satisfactory completion of the qualifying or preliminary examinations.

The Graduate School at North Carolina State University offers work leading to the Master of Science degree and the Professional Master's degree in certain specialized fields in the Schools of Agriculture and Life Sciences, Education, Engineering, Forest Resources, Physical Sciences and Applied Mathematics, and Textiles; and the Doctor of Philosophy degree in certain fields of agriculture and life sciences, engineering, forest resources, physical sciences and applied mathematics, and textiles. Work leading to the Master of Arts degree is offered in economics, English, history and politics.

A graduate student is expected to familiarize himself with the requirements for the degree for which he is a candidate and is held responsible for the fulfillment of these requirements. This applies to the last dates on which theses may be accepted, the dates for examinations, the proper form of theses and all other matters regarding requirements for degrees.

MASTER OF SCIENCE DEGREE

The Master of Science degree is awarded at North Carolina State University after a student has completed a course of study in a specialized field in agriculture and life sciences, education, engineering, forest resources, physical sciences and applied mathematics or textiles, has demonstrated his ability to read a modern foreign language, has completed a satisfactory thesis and has taken comprehensive examinations in the chosen field of study.

In addition to complying with these requirements, the candidate for the Master of Science degree is expected to achieve high levels of scholarship. Graduate study is distinguished from undergraduate work by its emphasis upon independent research. The graduate student is more interested in the significance of facts than in the accumulation of data. He is concerned with the materials of learning and the organization and interpretation of these materials.

A graduate student's program of study is planned so as to provide a comprehensive view of some major field of interest and to furnish the training essential for successful research in this field and related areas of knowledge. As great a latitude is permitted in the selection of courses as is compatible with a well-defined major interest. The program of course work is selected with the object of making possible a reasonable mastery of the subject matter in a specialized field. Training in research is provided to familiarize the student with the methods, ideals and goals of independent investigation. Since there are many possible combinations of courses, the administration of graduate programs calls for personal supervision of each student's plan of work by a special advisory committee of the graduate faculty. The program of course work to be followed by the student as part of the requirements for the master's degree, and the thesis problem selected, must be approved by the student's advisory committee and the dean of the Graduate School.

MASTER OF ARTS DEGREE

The Master of Arts degree is awarded in economics, English, history and politics. The above discussion concerning the Master of Science degree applies equally well to the Master of Arts degree.

CREDITS

1. For the Master of Science degree or the Master of Arts degree a minimum of 30 semester hours is required.
2. No more than six of the academic credits required for the degree will be accepted from other institutions.
3. No graduate credit will be awarded for excess undergraduate credit from another institution.
4. All work credited toward a master's degree must be completed within six calendar years.
5. No graduate credit is allowed for courses taken by correspondence. A maximum of six semester credits may be obtained in extension study in the field of education, provided the extension courses are taught by a member of the graduate faculty and provided the courses are given graduate ranking by the Graduate School. Courses taken by extension are accepted for graduate credit only when the student has been admitted to the Graduate School and when notice of his registration is filed with the Graduate Office. Credit for extension courses reduces the amount of credit that may be transferred from other institutions by the amount of graduate credit granted.

The 30 semester hour requirement for the master's degree represents the minimum quantity of work acceptable. The credit hours required of graduate students usually exceed the minimum requirements. Inadequate preparation and thesis research frequently make additional work necessary.

COURSES OF STUDY

The program of the student may include no more than six hours of research study nor more than two hours of departmental seminar. At least 20 semester hours must come from the 500- and 600-level group. Courses at the 400-level counted toward the minimal 30-hour requirement, may not ordinarily come from the major field.

During the first term in residence an advisory committee of at least three faculty members, one representing the minor field, will be appointed by the dean, after consultation with the head of the major department, for each student engaged in a program of work leading to the master's degree. The advisory committee will meet with the student and prepare a program of course work to meet the requirements of the student's graduate objectives. Four copies of the program, prepared on forms provided for this purpose, must be approved by each member of the committee, by the head of the major department and by the dean of the Graduate School. After approval in the Graduate Office, three copies will be returned to the department head—one for his files, one for the chairman of the advisory committee and one for the student.

The courses taken by a graduate student shall constitute a well-rounded but unified plan of study. This means that the program of research and course work shall be divided between a major and a minor field. While there are no inflexible rules which govern the number of credit hours that must constitute the major and minor, in general, it is expected that approximately two-thirds of the course work will fall in the major and one-third in the minor. The detailed course requirements for each graduate student program are left to the judgment of the advisory committee.

RESIDENCE

Students engaged in a course of study leading to the Master of Science or Master of Arts degree are required to be in residence, pursuing graduate work, one full academic year.

CLASS WORK

A graduate student is expected to show greater initiative in exploring the possibilities of the subject matter presented in the courses he takes than is the undergraduate. He is also expected to recognize the significance of facts and to assume a responsibility for relating data to theoretical concepts. In preparation, attendance and in all the routine of class work the graduate student is subject to the regulations observed in other divisions of the University.

GRADES

A minimum grade of "C" must be made on all formal course work to obtain graduate credit. An average of "B" must be obtained on all course work taken as part of the student's graduate program. Failure to maintain a "B" average will place the student on probation. Any student whose

academic record fails to meet the "B" average requirement for two consecutive terms will not be permitted to continue a graduate program without the written approval of the graduate dean.

Grades in research, seminar and special problems courses are given in terms of "S" (satisfactory) or "U" (unsatisfactory) in place of the symbols used for formal course work.

The grade *incomplete* may be used in research and laboratory courses when circumstances beyond the control of the student have prevented completion of the work by the end of the academic term. A grade of *incomplete* may be given only after approval of the graduate dean and must be converted to one of the usual symbols before the end of the next academic semester in which the student is in residence.

LANGUAGE REQUIREMENTS

A reading knowledge of at least one modern foreign language (Germanic, Romance or Slavic) is required of candidates for the Master of Science or Master of Arts degree.

The language requirement must be satisfied before a student can be admitted to candidacy.

Proficiency in languages is determined by the Department of Modern Languages:

1. By traditional reading knowledge examination at any time requested by the student.
2. By taking course work (audit) especially designed for graduate students who have no previous foreign language experience or who wish to refresh work formerly done. The department offers special courses beginning with elementary grammar and proceeding, during the semester, to general scientific reading. Pronunciation is emphasized to the degree in which it will help in translating from the language into English. This first course is followed by a second course in which the student selects work from scientific publications touching as nearly as possible his major interest. He will then be assigned a particular instructor with whom he will read in individual conferences. When the conference instructor is satisfied that the student has demonstrated his knowledge of intricate grammatical problems, a decrease in the time required for reading, and a confidence in his ability to use the language, he will be certified without further examination. The completed translations may then, depending upon their merit, be edited and prepared for permanent filing with the various translation libraries throughout the country.

Graduate students who expect to complete the requirements for the Master of Science or Master of Arts degree should confer with the head of the Department of Modern Languages soon after registration to formulate plans for meeting the language requirement of the degree.

Students whose native language is other than English may meet the foreign language requirement for the Master of Science or Master of Arts degree by demonstrating a satisfactory mastery of English. Examinations in English are conducted by the Department of Modern Languages.

THESIS

A candidate for the Master of Science or Master of Arts degree must prepare a thesis representing an original investigation. The subject of the thesis must be approved by the head of the department in which the major work is done and by the student's advisory committee. Three copies of the thesis in final form, and five copies of the abstract, must be filed in the Graduate Office at least one month before the degree is awarded. Detailed instructions as to form and organization of the thesis may be obtained at the Graduate Office.

EXAMINATIONS

All candidates for the Master of Science or Master of Arts degree must pass, with a grade of "A," "B" or "C," all formal course work specified as part of the requirements for the degree. Graduate credit for research, seminar, and special problems courses is granted when a grade of "S" is recorded in the Registration Office. In addition, the candidate must pass a comprehensive oral examination that is held to satisfy the examining committee that the candidate possesses a reasonable mastery of knowledge in the major and minor fields and that this knowledge can be used with promptness and accuracy. This examination may not be held until all other requirements, except completing the course work of the last semester, are satisfied. Application for the comprehensive oral examination must be filed with the graduate dean by the chairman of the advisory committee at least two weeks prior to the date on which the examination is to be held.

The oral examination will be conducted by an examining committee appointed by the graduate dean. The chairman of the examining committee will be the chairman of the student's advisory committee. At least two additional members will be appointed to represent the major and minor fields. The comprehensive oral examination is open to all faculty members who care to attend but the decision as to the candidate's fitness rests solely with the examining committee.

At the discretion of the examining committee, written examinations covering the subject matter in the major and minor fields also may be required of the candidate. Written examinations, when required, may not be held earlier than the end of the first month of the last semester in residence and not later than one week before the comprehensive oral examination. See Summary of Procedures for the Masters Degree, page 46.

MASTER'S DEGREE IN A PROFESSIONAL FIELD

This degree is offered for students who are interested in the more advanced applications of fundamental principles to specialized fields rather than in the acquisition of the broader background in advanced scientific studies which would fit them for careers in research. Students working for this degree ordinarily will terminate their graduate work at this point.

Examples of the types of degrees that may be awarded upon completion

of the course of study in a professional field are Master of Economics, Master of Education, Master of Forestry, Master of Biological and Agricultural Engineering, Master of Applied Mathematics, Master of Experimental Statistics, Master of Electrical Engineering, Master of Mechanical Engineering and Master of Textile Technology.

The chief characteristic of these degrees is that the changes made in requirements permit, in greater measure, the satisfaction of what are represented as professional needs than do the requirements for the conventional Master of Science or Master of Arts degree.

LANGUAGE REQUIREMENTS

The candidate for a master's degree in a professional field is exempt from the requirement of a reading knowledge of a modern foreign language.

THESIS REQUIREMENTS

In the School of Education the thesis requirement for the master's degree in each of the specialized fields may be waived by the department in which the degree is sought. When the thesis requirement is waived the student must complete the course "Introduction to Educational Research" or a departmental course in research, and a problem report. A thesis is not required in the Master of Forestry, Master of Applied Mathematics, Master of Experimental Statistics, Master of Electrical Engineering, Master of Mechanical Engineering or Master of Textile Technology programs, nor for professional degrees in the departments of the School of Agriculture and Life Sciences.

OTHER REQUIREMENTS

The other requirements for the master's degree in a professional field are the same as for the Master of Science degree.

MASTER OF AGRICULTURE DEGREE

This plan is offered for students interested in advanced training in the broad field of agriculture but whose responsibility is not in research. The requirements for the degree are designed to provide an opportunity for professional training without narrow specialization for those who plan to devote their lives to some phase of practical agriculture. Among the individuals interested in this degree are agricultural extension workers and foreign students who are in action or educational programs. The proposed plan differs from the plan for the Master of Science or Master of Arts degree in the following principal respects:

1. A total of 36 semester hours is required.
2. A minimum of four semester hours in special problems is required. Not more than six semester hours in special problems will be allowed. This work replaces the research thesis requirement for the Master of Science or Master of Arts degree.

3. There are no specific requirements as to courses in the 600 group.
4. A reading knowledge of a modern foreign language is not required.

In all other respects the requirements for the Master of Agriculture degree are the same as those for the Master of Science degree.

SUMMARY OF PROCEDURES FOR THE PROFESSIONAL MASTER'S DEGREE

1. Letter of inquiry from prospective student to Graduate School or department head.
2. Mailing of proper forms to student by Graduate School.
3. Receipt of application forms and transcripts by Graduate School.
4. Application with transcript sent to department head for study.
5. Department head recommends acceptance of prospective student stating curriculum in which he will work and the degree sought.
6. Assuming the prospective student meets the minimum scholastic standards, notice of acceptance is mailed to him by the Graduate School. When the student's academic record fails to meet the minimum scholastic standards of the Graduate School, provisional admission may be granted upon submission by the student of evidence of a satisfactory performance on the Graduate Record or National Teacher Examination. The National Teacher Examination is accepted only when approved by the department head and the graduate dean.
7. Permit to register is sent by the Graduate School to the registrar.
8. Student arrives, reports to the department head, is assigned an advisor and makes out a roster of courses in consultation with departmental advisor.
9. Advisory committee of three or more faculty members, one of whom represents the minor field, appointed before the end of the first semester of graduate study by the Graduate School after consultation with the department head. If departmental written examinations are required by the major department, there may be a minimum of two members on the advisory committee (one from the major field and one from the minor).
10. Plan of work prepared by the advisory committee in consultation with the student and submitted in quadruplicate to the Graduate School by the end of the first semester in residence.
11. Plan of work approved by the graduate dean and three copies returned to the department head. One copy is kept in department files, one goes to the advisor and one is given to the student. Students preparing themselves for the professional degree in specialized fields of education should consult the chairmen of their committees with reference to their problem report.
12. Student applies for admission to candidacy for the master's degree. Application must be filed before the end of the first week of the last semester in residence.

13. Application is reviewed by the head of the major department and by the graduate dean and, if approved, the student becomes a candidate for the degree.
14. Permission for the candidate to take the final oral examination is requested of the Graduate School at least two weeks before the examination.
15. Permission is granted by the graduate dean—date is set and examining committee appointed. The report on the final examination should be filed with the Graduate School as soon as the examination has been completed.
16. Graduate School certifies to the Registration Office and to the Administrative Board of the Graduate School that all requirements for the degree have been met and recommends the awarding of the degree.
17. All requirements must be completed within six calendar years.
18. Student must be registered in semester or session in which degree is to be awarded.

SUMMARY OF PROCEDURES FOR THE MASTER OF SCIENCE DEGREE AND THE MASTER OF ARTS DEGREE

1. Letter of inquiry from prospective student to Graduate School or department head.
2. Mailing of proper forms to student by Graduate School.
3. Receipt of application form and transcript by Graduate School.
4. Application with transcript sent to department head for study.
5. Department head recommends acceptance of prospective student stating curriculum in which he will work and the degree sought.
6. Assuming the prospective student meets the minimum scholastic standards, notice of acceptance is mailed to him by the Graduate School. When the student's academic record fails to meet the minimum scholastic standards of the Graduate School, provisional admission may be granted upon submission by the student of evidence of a satisfactory performance on the Graduate Record or National Teacher Examinations. The National Teacher Examination is accepted only when approved by the department head and the graduate dean.
7. Permit to register is sent by the Graduate School to the registrar.
8. Student arrives, reports to the department head, is assigned an advisor and makes out a roster of courses in consultation with department advisor.
9. Advisory committee of three or more faculty members, one of whom

- represents the minor field, appointed before the end of the first semester of graduate study by the Graduate School after consultation with the department head.
10. A thesis subject is selected and an outline of the proposed research submitted to the department head and to the student's advisory committee.
 11. Plan of work prepared by the advisory committee in consultation with the student and submitted in quadruplicate to the Graduate School by the end of the first semester in residence.
 12. Plan of work approved by the graduate dean and three copies returned to the department head. One copy is kept in department files, one goes to the advisor and one is given to the student.
 13. Student passes language examination. The language requirement must be satisfied before admission to candidacy can be granted.
 14. Student applies for admission to candidacy for the master's degree. Application must be filed before the end of the first week of the last semester in residence and may not be filed before the language requirement is satisfied.
 15. Application is reviewed by the head of the major department and by the graduate dean and, if approved, the student becomes a candidate for the degree.
 16. A copy of a preliminary draft of the thesis is submitted to the chairman of the student's committee for criticism.
 17. At least two weeks prior to the final oral examination, the chairman of the student's advisory committee submits a corrected draft of the dissertation to members for review.
 18. Permission for the candidate to take the final oral examination is requested of the Graduate School at least two weeks before the examination, and must be accompanied by a certification that the thesis is complete except for such revisions as may be necessary as a result of the final examination.
 19. Permission is granted by the graduate dean—date is set and examining committee appointed. The report on the final examination should be filed with the Graduate School as soon as the examination has been completed.
 20. Three copies of the thesis in final form approved by each member of the student's advisory committee and signed by the advisor must be submitted to the Graduate School at least four weeks before the end of the semester or summer session in which the degree is to be conferred.
 21. Graduate School certifies to the Registration Office and to the general faculty that all requirements for the degree have been met and recommends the awarding of the degree.
 22. All requirements must be completed within six calendar years.
 23. Student must be registered in term in which degree is to be awarded.

DOCTOR OF PHILOSOPHY DEGREE

The degree of Doctor of Philosophy is offered in the following fields of study:

Animal Science	Food Science
Applied Mathematics	Forestry
Biochemistry	Genetics
Biological and Agricultural Engineering	Industrial Engineering
Botany (in the fields of physiology and ecology)	Mechanical Engineering
Chemical Engineering	Microbiology
Chemistry	Mineral Industries (in the field of ceramic engineering)
Civil Engineering	Nuclear Engineering
Crop Science	Physics
Economics	Physiology
Electrical Engineering	Plant Pathology
Engineering Mechanics	Psychology
Entomology	Rural Sociology
Experimental Statistics	Soil Science
Fiber and Polymer Science	Wood Science and Technology
	Zoology

The doctor's degree symbolizes the fact that the recipient is capable of undertaking original research and scholarly work at the highest levels without supervision. Therefore, the Doctor of Philosophy degree is not granted on the basis of successful completion of a given amount of course work, but rather upon the demonstration by a candidate of a comprehensive knowledge and high attainment in scholarship and research in a specialized field of study. These attainments are determined by the quality of the dissertation which the candidate prepares to report the results of original investigations and by passing successfully a series of rigorous and comprehensive examinations on the special and related fields of study.

DOCTOR OF EDUCATION DEGREE

The School of Education offers graduate programs leading to the Ed.D. degree for majors in adult education and occupational education. Details are presented on page 106. The philosophy and requirements for the Ed.D. degree are the same as those expressed herein for the Doctor of Philosophy degree except that mastery of one foreign language, rather than two, is required.

COURSE OF STUDY

At the time of admission the student should, with the advice of the chairman of the department, elect a major field. During the student's first semester in residence, an advisory committee of at least four members will be appointed by the graduate dean, after consultation with the department head, to prepare with the student a plan of graduate work.

Four copies of the program, signed by all members of the advisory committee and the department head or graduate administrator, are referred to the graduate dean for approval. When approved, three copies are returned to the department head, one being retained in the department files, a second copy is given to the chairman of the advisory committee, and the third copy is given to the student. The subject of the dissertation must appear on the plan of work and any subsequent changes in the subject of the thesis or in the plan of graduate work must be reported to the Graduate School for approval.

There are no definite requirements in credit hours for the doctor's degree.

Major and Minor Fields: The Ph.D. degree is never granted for a program of miscellaneous studies. The program of work as a whole must be rationally unified and all constituent parts must contribute to an organized program of study and research. Courses must be selected from groups embracing one principal subject of concentration, called the major; and from cognate fields, called the minor. The minor program of study may be either a specific minor or interdisciplinary minor.

Specific Minor: Supplementary to his major study a candidate is required to offer a minor in a single discipline or field which, in the judgment of the student's advisory committee, provides relevant cognate support to the major field.

Interdisciplinary Minor: When an advisory committee finds that the needs of a doctoral student will be best served by preparation not available as a departmental minor, it has the alternative of developing a special program in lieu of the usual minor. To meet the requirements of this option a student may be required to complete courses in two or more departments outside his major, in related courses selected for their relevance to his particular area of concentration. Thus an appropriate program for a major in genetics might include courses in experimental statistics, biochemistry and physiology. In the case of a split minor the two pertinent disciplines may be so identified on the "program of work" forms.

RESIDENCE

For the Doctor of Philosophy degree and the Doctor of Education degree, the student is expected to be registered for graduate work for at least six semesters beyond the bachelor's degree at some accredited graduate school. The amount of work from other institutions credited to the fulfillment of degree requirements will be determined by the dean after consultation with the student's advisory committee at the time the plan of graduate work is filed.

At least two residence credits, as defined below, must be secured in continuous residence (registration in consecutive semesters) as a graduate student at some branch of the Consolidated University of North Carolina. Failure to take work during the summer does not break the continuity; however, summer school work can be used to fulfill this requirement.

Residence credit is based on the number of credits of graduate work beyond the bachelor's degree carried in a given term. During a regular semester, residence credit is calculated in the following manner:

<i>Semester Credits</i>	<i>Residence Credits</i>
9 or more	1
6 - 8	$\frac{2}{3}$
less than six*	$\frac{1}{3}$

The residence credit for a six-week summer term is only one-half the corresponding amount for a regular semester; i.e., six semester hours carry one-third residence credit and less than six credits, one-sixth residence credit. If a student registers for a 12-week summer term, the residence credit is computed as for regular semesters. If a student registers for both 12-week and six-week summer terms, the residence credit is computed separately for each type and totaled, with the stipulation that no more than one residence credit can be earned in a given summer.

The candidate must complete all requirements for the degree, including the final examination on his dissertation, within a period of seven calendar years from the date of admission to candidacy for the degree.

LANGUAGES

A reading knowledge of scientific literature in two modern foreign languages or a comprehension in depth of one language is required for the Doctor of Philosophy degree. For the Doctor of Education degree a reading knowledge of only one language is required.

Comprehension in depth is to be interpreted as a proven ability in the oral and composition elements of a particular language as well as the reading knowledge normally required. Ph.D. students desiring to offer one language in depth should consult with the head of the Department of Modern Languages as to the specific courses to be followed to achieve this comprehension. Specific arrangements may differ, depending upon the student's previous background in the language. It is emphasized that students choosing to achieve competence in depth in one language will generally find this alternative more rigorous than proof of reading ability in two languages.

If the student elects to work in two languages, the languages may be a combination of Romance and Slavic, Romance and Germanic, or Slavic and Germanic.

Students whose native tongue is some language other than English may use English as one of the languages required for the Doctor of Philosophy degree. When English is submitted in partial fulfillment of the language requirements, the native language may not be used to satisfy one of the language requirements.

THE DISSERTATION

The doctoral dissertation presents the results of the candidate's original investigations in the field of his major interest. It must represent

* Including registration for thesis preparation on campus.

a contribution to knowledge, adequately supported by data and written in a manner consistent with high standards of excellence in scholarship. Detailed instructions relating to the thesis may be obtained from the Graduate Office.

Publication of the results obtained in the thesis investigation is expected. Each copy of the thesis must be accompanied by an abstract of approximately 500 words.

The dissertation will be examined by all members of the examining committee and must receive their approval to be acceptable to the Graduate Office.

Two copies of the dissertation in final form, signed by all members of the student's advisory committee, and five copies of the abstract must be presented to the Graduate School not later than four weeks before the date on which the degree is to be awarded.

North Carolina State now has an agreement with University Microfilms, Inc., of Ann Arbor, Michigan, by which all doctoral dissertations are microfilmed and abstracts of the dissertations are published in "Dissertation Abstracts."

EXAMINATIONS

Not earlier than the end of the second year of graduate study and not later than the midpoint of the semester immediately preceding that in which the degree is expected, each doctoral student is required to pass general comprehensive examinations (known as the qualifying or preliminary examinations). If summer sessions are involved, the two consecutive summer sessions are, for these purposes, considered as equivalent to one semester. The examinations are given by an examining committee of graduate faculty members appointed by the graduate dean after consultation with the head of the department in which the student's major work has been taken. The examining committee usually consists of the student's advisory committee and a representative of the Graduate School, but may include other members of the graduate faculty. The examinations are open to all members of the graduate faculty who may care to attend.

Authorization for the qualifying examination is requested of the Graduate School by the chairman of the student's advisory committee when the major part of the student's program of course work has been completed and when, in judgment of the committee, the student is prepared to devote the greater part of his time to the prosecution of his research study. Members of the examining committee will be notified of their appointment by the Graduate Office. Official printed forms will be supplied to the chairman of the examining committee for a report of the results of the examination.

The examination consists of two parts—written examinations and an oral examination held before the entire examining committee. When, in the judgment of the chairman of the student's advisory committee, the student is ready for the written examinations, arrangements may be made. Two approaches are acceptable. In the first, the chairman requests examination questions from each member of the examining committee. Each set of questions is given to the student by the chairman in

any order that may seem appropriate. The questions, together with the student's answers, are then returned to the members of the committee for grading. This procedure is still used by departments having a relatively small number of doctoral candidates. Many of the larger departments, however, have found it impractical to have separate written examinations prepared by each student's committee and have instituted departmental written examinations to be used for all candidates. These examinations are given several times during the year and scheduled dates are announced well in advance. Where written departmental examinations of this kind are made available, the student majoring or minoring in the field of the department will be expected to make arrangements for taking these examinations. Questions on written examinations may cover any phase of the course work taken by the student during the period of his graduate study or any subject logically related and basic to an understanding of the subject matter of the major and minor areas of study. They should be designed to measure the student's mastery of these subject matter fields and the adequacy of his preparation for research investigations.

Upon satisfactory completion of the written examinations the student must pass an oral examination before the entire examining committee. This examination is usually held within a week after the chairman of the examining committee has certified to the Graduate School that the student has completed satisfactorily the written examinations. The members of the examining committee will be notified by the Graduate School of the time and place arranged for the oral examination. The oral examination is designed to test the student's ability to relate factual knowledge to specific circumstances. In the oral examination the student is expected to use his knowledge with accuracy and promptness and to demonstrate that his thinking is not limited to the facts learned in course work.

A unanimous vote of approval is required for passing the preliminary examination. Approval may be conditioned, however, upon the completion of additional work in some particular field to the satisfaction of the committee. In case a single dissenting vote is cast, the course of action to be taken will become a matter for decision by the Administrative Board. Upon receiving the approval of the examining committee the student is admitted to candidacy for the doctorate.

A final oral examination is also required. During a normal academic year, an interval of at least eight months must elapse between admission to candidacy and the final oral examination. If summer sessions are involved, this interval may be interpreted to include two consecutive summer sessions and one academic semester.

This examination is held after the dissertation has been completed and consists of a defense by the candidate of the methods used and the conclusions reached in his research study. The examination is conducted by an examining committee. The examining committee usually includes the student's advisory committee, plus a representative of the Graduate School, although this procedure is not always adopted. The examining committee is appointed by the graduate dean after consultation with the head of the student's major department.

Failure of a student to pass either the preliminary or the final examination terminates his graduate work at this institution unless otherwise

recommended by the examining committee. No reexamination may be given until at least one full semester has elapsed since the first examination. Only one reexamination is permitted.

See Summary of Procedures for Doctor of Philosophy and Doctor of Education Degrees below.

ADMISSION TO CANDIDACY

A student is admitted to candidacy after he has successfully passed the preliminary examinations. The language requirements must be fulfilled before permission to take the preliminary examination is granted. Admission to candidacy must be obtained not later than the midpoint of the semester immediately preceding that in which the degree is expected.

ADDITIONAL INFORMATION

A booklet containing detailed instructions about the form of the dissertation may be obtained from the Graduate School.

Further information concerning graduate work at North Carolina State University may be secured from *Dr. Walter J. Peterson, Dean of the Graduate School, North Carolina State University at Raleigh, Raleigh, North Carolina 27607.*

SUMMARY OF PROCEDURES FOR THE DOCTOR OF PHILOSOPHY AND DOCTOR OF EDUCATION DEGREES

1. Letter of inquiry from prospective student to Graduate School or department head.
2. Mailing of proper forms to student by Graduate School.
3. Receipt of application forms by Graduate School.
4. Application with transcript sent to department head for study.
5. Department head recommends acceptance of prospective student stating curriculum in which he will work.
6. Assuming the prospective student meets the minimum scholastic standards, notice of acceptance is mailed to him by the Graduate School.
7. Permit to register is sent by Graduate School to the registrar.
8. Student arrives, reports to the department head, is assigned an advisor, and makes out a roster of courses in consultation with departmental advisor.
9. Advisory committee of at least four members is appointed in the first term of graduate study by the graduate dean after consultation with the department head.
10. Plan of work is prepared by the advisory committee in consultation with the student and submitted in quadruplicate to the Graduate School by the end of the first semester in residence.

11. Plan of work is approved by the graduate dean and three copies returned to the department head. One copy is kept in department files, one goes to the advisor, and one is given to the student.
12. A dissertation subject is selected and an outline of the proposed research submitted to the department head and the student's advisory committee.
13. Student passes language examinations.
14. When the student has completed satisfactorily all the courses in the minor field on his plan of work, he may, with the consent of the chairman of his committee, take the written qualifying examination in the field of his minor. If desirable, this examination may be taken if all but one of the courses in the minor field have been completed and the student is taking the last such course during the semester in which the examination is held. The results of this examination will be reported to the Graduate School. The examination in the minor field may be combined with the examination in the major field.
15. The written examination in the major field may be scheduled upon approval of the dean of the Graduate School not earlier than the end of the second year of graduate study and not later than the midpoint of the semester immediately preceding that in which the degree is expected. The results of this examination will be reported to the Graduate School.
16. When all written examinations have been completed satisfactorily, the oral qualifying examination may be held. The Graduate School is notified two weeks in advanced of the time and place of this examination. The report of the examination is sent to the Graduate School. If the report is favorable, the student is admitted to candidacy.
17. A copy of the preliminary draft of the dissertation is submitted to the chairman of the student's committee for criticism.
18. At least two weeks prior to the final oral examination, the chairman of the student's advisory committee submits a corrected draft of the dissertation to members for review.
19. Eight months (or two terms) after admission to candidacy or later, permission for the candidate to take the final oral examination is requested of the Graduate School by the chairman of the candidate's advisory committee. Requests should be filed at least two weeks before the date of the examination and must be accompanied by a certification that the thesis is complete except for such revisions as may be necessary as a result of the final examination.
20. Permission is granted by the graduate dean if the student's record is in order. A date is set and examining committee appointed. The report on the examination should be filed with the Graduate School as soon as examination has been completed.
21. Two copies of the thesis in final form and five copies of the abstract must be submitted to the Graduate School not later than four weeks before the date on which the degree is to be awarded. It must carry the signatures of all members of the advisory committee.

22. The Graduate School certifies to the Registration Office and to the general faculty that all requirements for the degree have been met and recommends the awarding of the degree.
23. All requirements must be completed within seven calendar years from date of admission to candidacy for the doctoral degree.
24. The student must be registered in the term in which the degree is to be awarded.



A major attraction at State is the mall at the center of the campus. When weather permits, it also serves as a pleasant place for study.

FIELDS OF INSTRUCTION

The course descriptions are planned for the academic years 1968-69 and 1969-70, unless indicated otherwise. Specific courses may not be offered, however, if registration for a course is too low, or if faculty or facilities are not available.

Courses in the 500 series are open to seniors and graduate students. All courses in this series carry full graduate credit. Courses in the 600 series are open to graduate students only. Master's programs must include not less than 20 semester hours from courses in the 500 and 600 series.

In a typical course description, the semester hours of credit, the number of actual lecture and laboratory hours of meeting per week, and the term or terms in which the course is offered are shown in this manner: 2(1-2) FS Sum. or 1-3 FS Sum.

The 2 indicates the number of semester hours credit given for satisfactory completion of the course. The (1-2) indicates that the course meets for one hour of lecture and for two hours of laboratory work each week. The 1-3 indicates that a maximum of three and a minimum of one semester hours credit can be earned. This is to be arranged with the instructor. The F designates the course to be given in the fall semester. Likewise, the S designates spring and the Sum., summer.

ADULT EDUCATION

GRADUATE FACULTY

Professor EDGAR J. BOONE, *Head*

Professors: J. B. ADAIR, EMILY H. QUINN; *Associate Professors:* DEWEY A. ADAMS, ROBERT J. DOLAN; *Assistant Professors:* LACY G. HALL, CHARLES J. LAW, JR., GEORGE D. RUSSELL

The Department of Adult Education offers programs of study leading to the Master of Education and Master of Science degrees and the Doctor of Education degree with a major in adult education.

The program is based upon an interdisciplinary approach and is designed to provide graduate students the opportunity to develop a broad and comprehensive understanding of adult education and a high level of professional competence in conducting research. Bolstering the interdisciplinary base of the graduate program is the Graduate Institute of Adult Education, administered by an Administrative Board, which includes the deans of the Schools of Agriculture and Life Sciences, Education, Liberal Arts, the Graduate School at North Carolina State University and the dean of the School of Home Economics at the University of North Carolina at Greensboro.

A candidate for an advanced degree in adult education must acquire a comprehensive understanding of the adult and society, and the theories of learning, social action, group processes, communication and planning requisite to effecting change among people. While a basic comprehension of these relevant theories is the first essential, the candidate must also understand their interrelationships and how they apply to adult education. The degree candidate must present a thesis or dissertation based on his own research.

The basic aspects of the behavioral sciences as related to adult education is the central theme of the Department of Adult Education's graduate program. The varied but coordinated interests of the department's faculty with their research programs offer a variety of opportunities for graduate student training that is found in few institutions.

The Department of Adult Education is housed in Ricks Hall. It has a modern and well-equipped department library including all major professional journals in adult education and the behavioral sciences.

FOR GRADUATES AND ADVANCED UNDERGRADUATES

ED 501 (SOC 501) LEADERSHIP 3(3-0) S
(See Sociology, page 237.)

ED 502 (PS 502) PUBLIC ADMINISTRATION 3(3-0) S
(See Politics, page 226.)

ED 503 THE PROGRAMMING PROCESS IN ADULT EDUCATION 3(3-0) S
Prerequisites: ED 501, consent of instructor

The principles and processes involved in programming, including basic theories and concepts supporting the programming process. Attention will be given to the general framework in which programming is done, the organization needed and the program roles of both professional and lay leaders
Mr. Boone

**ED 510 ADULT EDUCATION: HISTORY, PHILOSOPHY,
CONTEMPORARY NATURE** 3(3-0) F
Prerequisite: Graduate standing

A study of the historical and philosophical foundations of adult education from ancient times to the present, giving attention to key figures, issues, institutions, movements and programs, including consideration of the relationship between adult education's historical development and prevailing intellectual, social, economic and political conditions. Consideration of adult education's contemporary nature, present-day schools of thought on its objectives and trends. Mr. Russell

ED 513 (SOC 513) COMMUNITY ORGANIZATION 3(3-0) S
(See Sociology, page 238.)

ED 559 PRINCIPLES OF ADULT EDUCATION 3(3-0) F
Prerequisite: Six hours in education

Principles involved in adult education programs including theories and concepts undergirding and requisite to these programs. Emphasis will be given to the interrelationship of the nature of adult learning, the nature of the subject matter and the setting in which learning occurs. The applicability of relevant principles and pertinent research findings to adult learning will be thoroughly treated.
Mrs. Quinn

ED 596 TOPICAL PROBLEMS IN ADULT EDUCATION Credits Arranged

Study and scientific analysis of problems in adult education, and preparation of a scholarly research type of paper. Graduate Staff

FOR GRADUATES ONLY**ED 600 THEORY OF ORGANIZATION AND ADMINISTRATION
IN ADULT EDUCATION I 3(3-0) F**

Prerequisites: ED 503, PS 502, SOC 541

Theory of organization relating to adult education social systems as a basis for understanding administrative behavior. An in-depth analysis of the structure, function and process of adult education social systems, patterns of organizational growth and change, behavior patterns of functionaries and reciprocal influence of the adult education system and other social systems in the society. Mr. Dolan

**ED 601 THEORY OF ORGANIZATION AND ADMINISTRATION
IN ADULT EDUCATION II 3(3-0) S**

Prerequisite: ED 600

Philosophy of administration as a basis for administering an adult education institution. Theory relevant to administration of such an organization. Principles of administration as they relate to planning, organizing, staffing, initiating, delegating, integrating, motivating, decision-making, communicating, establishing standards, financing and budget defense and control, and measuring results. Administrative behavior of the adult education executive. Messrs. Boone, Adams

ED 696 SEMINAR IN ADULT EDUCATION 1(1-0) FS

Identification and scientific analysis of major issues and problems relevant to adult education. Credit for this course will involve the active participation of the student in a formal seminar and the scientific appraisal and solution of a selected problem. The course is designed to help the student acquire a broad perspective of issues confronting adult educators and to acquire experience in the scientific analysis and solution of specific issues. Graduate Staff

AGRICULTURAL EDUCATION**GRADUATE FACULTY**

Professor CLARENCE C. SCARBOROUGH, *Head*

Professors: J. BRYANT KIRKLAND, JOHN K. COSTER; *Associate Professors:* HARRY G. BEARD, TEXTON R. MILLER; *Assistant Professors:* WILLIAM J. BROWN, JR., CHARLES D. BRYANT, CHARLES I. JONES, CHARLES H. ROGERS

The Department of Agricultural Education offers programs of study leading to the Master of Science, the Master of Education and the Doctor of Education degrees. Graduate programs are designed to meet the needs of individual students for further study and research as well as to prepare for educational leadership roles in teaching, administration, supervision and research. All programs emphasize research. As part of the graduate program, each student must complete a thesis or a research problem.

In addition to the many resources available to all North Carolina State

graduate students, agricultural education students have an additional resource available in administrative and supervisory staff members of the State Department of Public Instruction and the Department of Community Colleges in Raleigh.

A number of graduate assistantships are available, both teaching and research. A concerted effort is made to insure that the assistantship experiences are related to the career plans of individual students.

FOR GRADUATES AND ADVANCED UNDERGRADUATES

ED 554 PLANNING PROGRAMS IN AGRICULTURAL EDUCATION 3 (3-0) S
Prerequisite: ED 411 or equivalent

Analysis of theory of planning and change. Consideration of the need for planning programs in agricultural education; objectives and evaluation of community programs; use of advisory groups; organization and use of facilities; role of the leader. Mr. Scarborough, Graduate Staff

ED 568 ADULT EDUCATION IN AGRICULTURE 3 (3-0) FS
Prerequisite: ED 411 or equivalent

Designed to meet the needs of leaders in adult education. Opportunity to study some of the basic problems and values in working with adult groups. Particular attention will be given to the leadership role in educational programs for adults. Mr. Scarborough, Graduate Staff

ED 593 SPECIAL PROBLEMS Credits Arranged
Prerequisite: ED 411 or equivalent

Opportunities for students to study current problems under the guidance of the staff. Graduate Staff

FOR GRADUATES ONLY

ED 617 PHILOSOPHY OF AGRICULTURAL EDUCATION 3 (3-0) S
Prerequisite: ED 554 or equivalent

An examination of educational philosophies and their relation to current educational programs in agricultural education. Mr. Scarborough, Graduate Staff

ED 664 SUPERVISION IN AGRICULTURAL EDUCATION 3 (3-0) F
Prerequisite: ED 563 or equivalent

Organization, administration, evaluation and possible improvement of supervisory practice; theory, principles and techniques of effective supervision in agricultural education at different levels. Mr. Scarborough, Graduate Staff

ED 693 ADVANCED PROBLEMS Credits Arranged
Prerequisite: ED 593 or equivalent

Study of current and advanced problems in the teaching and administration of educational programs, evaluation of procedures and consideration for improving. Graduate Staff

ED 694 SEMINAR IN AGRICULTURAL EDUCATION 1 (1-0) FS
A critical review of current problems, articles and books of interest to students of agricultural education. Graduate Staff

ANIMAL SCIENCE

GRADUATE FACULTY

Professor IRA D. PORTERFIELD, *Head*

Professors: ELLIOTT R. BARRICK, EDWARD G. BATTE, ROBERT F. BEHLOW, LEMUEL GOODE, GEORGE HYATT, JR., JAMES G. LECCE, JAMES E. LEGATES, GENNARD MATRONE, HAROLD A. RAMSEY, FRANK H. SMITH, HAMILTON A. STEWART, SAMUEL B. TOVE, LESTER C. ULBERG, GEORGE H. WISE, MILTON B. WISE; *Associate Professors:* ALBERT J. CLAWSON, DONALD G. DAVENPORT, EMMETT U. DILLARD, EUGENE J. EISEN, JAMES M. LEATHERWOOD, ROBERT L. MCGUIRE, JOHN J. MCNEILL, RICHARD D. MOCHRIE, DANIEL J. MONCOL, ALLEN H. RAKES, ODIS W. ROBISON; *Assistant Professors:* WILLIAM L. ALSMEYER, EDWARD V. CARUOLO, EVAN E. JONES, JAMES R. JONES, RICHARD M. MYERS, JOHN H. NICOLAI, JR., FRANK D. SARGENT

The Department of Animal Science offers programs leading to the degrees of Master of Science and Doctor of Philosophy in three sections—animal breeding, animal diseases and nutritional biochemistry—that are functionally oriented and in two sections—animal husbandry and dairy husbandry—that are commodity oriented. The interrelationships among these are such that a student choosing one benefits from close association with the others. The goals of all are to provide challenging programs, offering him an opportunity to develop his creative ability to such an extent that he will have the knowledge and motivation to contribute significantly to his chosen profession or closely related fields.

The availability of a variety of modern laboratories, specialized equipment and experimental subjects enables the student to become familiar with research tools and their use in expanding knowledge in the several segments of animal science. The research experience gained in fulfilling the requirements for degrees, more than any other single factor, determines the specialization characteristics in animal science.

Students in animal breeding concentrate on problems pertaining to the efficient utilization of superior germ plasm. Emphasis is given to both quantitative genetics and reproductive physiology. Experimental subjects include livestock and small animals. Among the modern facilities is a laboratory designed specifically for the study of the various factors affecting reproduction.

Students in the animal disease area may specialize in pathology, parasitology, veterinary microbiology, virology or other phases of disease. A modern building, including appropriate laboratories and equipment, is provided for research and training in these subjects.

Students in nutritional biochemistry are trained, primarily, in the fundamental aspects of this field. Programs are oriented toward the basic phases of nutrition, including the metabolism of carbohydrates, proteins, lipids and minerals; the biochemistry, physiology and microbiology of digestion; and the mechanisms of control of biosynthesis and biodegradation. Excellent laboratory facilities are available.

Students in animal husbandry may select problems in nutrition, developmental physiology, carcass quality, production efficiency and the interre-

relationships of breeding, feeding and management of those species of livestock classified as meat animals.

Dairy husbandry graduate students have options of nutrition, physiology or dairy cattle management for major emphasis in their programs.

In the husbandry sections, livestock, farms, feeding facilities and laboratories are such that a variety of problems may be used effectively in graduate programs.

Strong collateral support, through course offerings and research cooperation, is available in the areas of biochemistry, physiology, genetics, microbiology, statistics, economics and food science; hence graduate programs in animal science afford opportunities for the multidimensional development of students.

FOR ADVANCED UNDERGRADUATES

ANS 401 REPRODUCTIVE PHYSIOLOGY

3(2-3) S

Prerequisite: ZO 421

Current concepts of physiology as related to mammalian reproduction. Emphasis is placed upon understanding physiological processes, how they are influenced by external forces and their importance in reproductive performance. The student is required to select, design and conduct a special research project.

Messrs. Myers, Ulberg

ANS 402 BEEF CATTLE MANAGEMENT

3(2-3) S

Prerequisite: ANS 204

A study of modern principles and practices in beef cattle care and management. Special emphasis is placed upon the application of the principles of genetics, ruminant nutrition and animal health to cow-calf programs and to stocker and feeder cattle operations.

Mr. Wise

ANS 403 SWINE MANAGEMENT

3(2-3) S

Prerequisite: ANS 204

A study of the economic, nutritional, genetic, physiological and managerial factors affecting the operation of modern swine enterprises.

Mr. Clawson

ANS 404 DAIRY CATTLE MANAGEMENT

3(2-3) S

Prerequisite: ANS 204

A study of practical dairy farm management, including feed acquisition and utilization, breeding and selection, health and sanitation, herd replacements and dairy farm buildings. Particular emphasis is placed upon the consequences of management alternatives and the importance of herd and farm business records.

Mr. Davenport

ANS 405 LACTATION

2(1-3) F

Prerequisite: ZO 421

Gross and microscopic anatomy of the developing and the mature mammary gland. Physiological processes involved in milk secretion and removal of milk from the gland. A special research project is required.

Mr. Mochrie

ANS 406 SHEEP MANAGEMENT

3(2-3) F

Prerequisite: ANS 204

A study of the economic, genetic, nutritional, physiological and managerial factors affecting the operation of the modern sheep enterprise.

Mr. Goode

- ANS 410 HORSE MANAGEMENT** 2(2-0) F
Application of fundamentals of selection, nutrition, breeding and animal health to light horses. Managerial details of horse care are covered. Mr. Barrick
- ANS 490 ANIMAL SCIENCE SEMINAR** 1(1-0) S
Review and discussion of special topics and the current literature pertaining to all phases of animal science. Mr. Porterfield

FOR GRADUATES AND ADVANCED UNDERGRADUATES

- ANS 503 (GN 503) GENETIC IMPROVEMENT OF LIVESTOCK AND POULTRY** 3(2-3) F
Prerequisite: GN 411 or equivalent
The application of genetic principles to the economic improvement of animal agriculture. Phenotypic and genetic relationships among economic traits as well as mode of inheritance and method of measurement of the traits. The roles of inbreeding, outbreeding and selection methods in producing superior genetic populations. Mr. Robison
- ANS 505 DISEASES OF FARM ANIMALS** 3(3-0) F
Prerequisites: CH 101, CH 103
The pathology of bacterial, viral, parasitic, nutritional, thermal and mechanical disease processes. Mr. Batte
- ANS 513 NEEDS AND UTILIZATION OF NUTRIENTS BY LIVESTOCK** 3(3-0) S
Prerequisite: ANS 312 or equivalent
Fundamental aspects of nutrient utilization, including digestion, absorption and metabolism, relationships of energy metabolism to energy source, body function and other factors affecting its control. Mr. Leatherwood
- ANS 590 TOPICAL PROBLEMS IN ANIMAL SCIENCE** Maximum 6 FS
Special problems may be selected or assigned in various phases of animal science. Graduate Staff

FOR GRADUATES ONLY

- ANS 603 (GN 603) POPULATION GENETICS IN ANIMAL IMPROVEMENT** 3(3-0) F
Prerequisites: GN 512, ST 512
A study of the forces influencing gene frequencies, inbreeding and its effects, and alternative breeding plans. Mr. Legates
- ANS 604 EXPERIMENTAL ANIMAL PHYSIOLOGY** 4(2-4) F
Prerequisite: ZO 513 or equivalent
A study of the theories and techniques involved in the use of animals in physiological investigation. Messrs. Ulberg, Wise
- ANS 622 (ST 622) PRINCIPLES OF BIOLOGICAL ASSAYS** 3(3-0) S
Prerequisites: BCH 551, ST 512
Techniques and designs of biological assays. The interrelationship of logical principles, designs and analyses is emphasized. Graduate Staff
- ANS 653 (BCH 653) MINERAL METABOLISM** 3(3-0) F
(See Biochemistry, page 65.)

ANS 690 SEMINAR IN ANIMAL NUTRITION

1(1-0) FS

Prerequisite: Consent of seminar leaders

Orientation in philosophy of research, preparation for research and general research methodology. Graduate Staff

ANS 699 RESEARCH IN ANIMAL SCIENCE

Credits Arranged

A maximum of six hours is allowed toward the master's degree; no limitation on credits in doctorate program. Graduate Staff

BIOCHEMISTRY

GRADUATE FACULTY

Professor GENNARD MATRONE, *Head*

Professors: IAN S. LONGMUIR, A. RUSSELL MAIN, SAMUEL B. TOVE; *Associate Professors:* FRANK B. ARMSTRONG, H. ROBERT HORTON, JOSEPH S. KAHN, EDWARD C. SISLER

ASSOCIATE MEMBERS OF THE DEPARTMENT

Professor: LEONARD W. AURAND; *Associate Professor:* SAMUEL G. LEVINE;
Assistant Professor: EVAN E. JONES

The field of biochemistry applies and extends the concepts of chemistry and physics to the investigation of biological problems. The Department of Biochemistry offers courses of study leading to the degrees, Master of Science and Doctor of Philosophy.

A student entering into graduate study in biochemistry should have a bachelor's degree in chemistry or a biological science. The undergraduate program of studies should include two semesters of organic chemistry, one of quantitative analysis and two semesters of physical chemistry. Students who lack undergraduate courses considered essential for graduate study in biochemistry may be admitted to the graduate program; however, appropriate course work to make up academic deficiencies must be successfully completed early in their graduate studies.

Courses in General Biochemistry (BCH 551) and Intermediary Metabolism (BCH 655 and BCH 657) are required as part of the program leading to advanced degrees (majors and minors) in biochemistry.

In addition to completing a program of studies approved by his advisory committee, a candidate for an advanced degree in biochemistry is expected to participate regularly in biochemistry seminars throughout his graduate residence, and to engage in independent research leading to the completion of a scholarly thesis. Research programs are currently being conducted in biochemical genetics, enzyme structure and mechanisms, inhibition kinetics, biochemical aspects of toxicology, biochemical control mechanisms, photosynthesis, developmental biochemistry of plants, methylation reactions in plants, lipid metabolism, volatile fatty acid metabolism, biochemical role of copper, metal ion interactions *in vivo* and *in vitro*, and oxygen transport mechanisms.

FOR GRADUATES AND ADVANCED UNDERGRADUATES

BCH 551 GENERAL BIOCHEMISTRY 3(3-0) F
 Prerequisites: Three years chemistry, including CH 223; CH 431 strongly recommended

Principles of modern biochemistry, including a study of structural and metabolic relationships of carbohydrates, lipids, proteins, nucleic acids, enzymes and coenzymes. Mr. Jones

BCH 554 RADIOISOTOPE TECHNIQUES IN BIOLOGY 2(1-3). F
 Prerequisite: BCH 551 or CH 433 or CH 435

The theory and application of the radioisotope techniques used in biology. The different modes of radioactivity are correlated with methods of measurement. Emphasis is placed on the use and limitations of various instruments and techniques and on their application to research problems. Mr. Matrone

BCH 557 INTRODUCTORY ENZYME KINETICS 3(3-0) S
 Prerequisites: BCH 551, MA 201 or MA 212

The basic principles of chemical kinetics, applied to the development of enzyme kinetics. Limitations of the Michaelis equation are considered in the light of the general rate equation. Inhibition and activation, pH functions, effects of temperature and elucidation of mechanisms are also considered. Mr. Main

BCH 561 (GN 561, MB 561) BIOCHEMICAL AND MICROBIAL GENETICS 3(3-0) F
 Prerequisite: GN 505 or consent of instructor

A study of the development of the fields of biochemical genetics and microbial genetics, emphasizing both techniques and concepts currently used in research in these areas. Includes lectures and discussions of current research publications. Mr. Armstrong

FOR GRADUATES ONLY

BCH 651 PHYSICAL BIOCHEMISTRY 3(3-0) S
 Prerequisite: CH 433 or CH 435

Structural and physical properties of biological macromolecules, and the application of physical methods to their study. Messrs. Kahn, Longmuir

BCH 652 BIOCHEMICAL RESEARCH TECHNIQUES 3(0-8) F
 Prerequisites: BCH 551, CH 215 or CH 411, or equivalent

Instrumentation and techniques for separation, identification and characterization of biochemical constituents; laboratory methods of isolation, assay and characterization of enzymes; kinetics of enzyme catalyzed reactions. Mr. Kahn, Graduate Staff

BCH 653 (ANS 653) MINERAL METABOLISM 3(3-0) F
 Prerequisite: BCH 551

Principles of mineral metabolism with emphasis on metabolic functions, reaction mechanisms and interrelationships. Mr. Matrone

BCH 655 INTERMEDIARY METABOLISM I 3(3-0) S
 Prerequisite: BCH 551

A study of carbohydrate, lipid and energy metabolism. Mr. Tove

BCH 657 INTERMEDIARY METABOLISM II 3(3-0) F
 Prerequisite: BCH 551

A study of amino acid, protein and nucleic acid metabolism. Mr. Horton

BCH 659 (CH 659) NATURAL PRODUCTS
(See Chemistry, page 85.)

3(3-0) F

BCH 691 SEMINAR IN BIOCHEMISTRY

Credits Arranged
Graduate Staff

BCH 695 SPECIAL TOPICS IN BIOCHEMISTRY

Credits Arranged

Prerequisite: Graduate standing in biochemistry

Critical study of special problems in modern biochemistry.

Graduate Staff

BCH 699 BIOCHEMICAL RESEARCH

Credits Arranged
Graduate Staff

BIOLOGICAL AND AGRICULTURAL ENGINEERING

GRADUATE FACULTY

Professor FRANCIS J. HASSLER, *Head*

Professors: HENRY D. BOWEN, WILLIAM E. SPLINTER; *Associate Professors:* JAMES W. DICKENS, DAVID H. HOWELLS, BARNEY K. HUANG, WILLIAM H. JOHNSON, DAVID A. LINK, CHARLES W. SUGGS, RALPH E. WILLIAMSON, EDWARD H. WISER; *Assistant Professors:* ERVIN G. HUMPHRIES, GEORGE J. KRIZ, WILLIAM F. MCCLURE, CLIFF R. WILLEY, JAMES H. YOUNG

The Department of Biological and Agricultural Engineering offers programs of study for the Master of Science, Doctor of Philosophy and Master of Biological and Agricultural Engineering degrees. A bachelor's degree in agricultural engineering from an accredited curriculum or its equivalent provides the necessary background for graduate study.

For those interested primarily in a broadened background in existing engineering technology without the necessity for preparing a thesis, the Master of Biological and Agricultural Engineering program permits selection from a variety of advanced technical courses. Such study is appropriate to certain supervisory and managerial positions, technical sales, service and promotional work.

The Master of Science program takes into account the increasing rigor of modern science and engineering. Emphasis here is on mathematics and theory as the unifying link between otherwise widely divergent fields of knowledge in the biological and physical sciences, and as prerequisites to effective engineering advances in biological and agricultural areas. As the student acquires competence in the advanced methods of science, he applies his knowledge by conducting an original research investigation and by writing and defending a thesis.

Study for the Doctor of Philosophy degree builds on the Master of Science program with an additional year of formal study followed by a period of independent research to satisfy dissertation requirements. Doctoral research is expected to be an original and valuable addition to the existing body of scientific and technical knowledge.

Unusual opportunities are available for graduate student participation in departmental research programs. Current projects include: watershed hydrology; drainage and irrigation; crop processing and materials handling; functional development of field machinery; fruit and vegetable mechanization; pesticide application; human engineering; operations research; biological instrumentation; and engineering aspects of plant and animal physiology.

Graduate students have access to well-equipped research laboratories, controlled-environment chambers, a research shop manned by competent mechanics, and excellent analog and digital computing facilities.

Information concerning fellowships and assistantships may be obtained from the head of the department.

FOR ADVANCED UNDERGRADUATES

BAE 411 FARM POWER AND MACHINERY 3(2-3) FS
Prerequisites: BAE 211, PY 211 or PY 221

This course is designed to provide students in agricultural engineering technology with a knowledge of the operations of manufacturing and distribution organizations of farm machinery and their places in these organizations. Included is a practical course in farm tractors and engines with emphasis on familiarizing the student with component parts—their application, operation and maintenance, as well as with the selection of these units from the standpoint of power, performance and ratings.

Mr. Fore

BAE 433 CROP PRESERVATION AND PROCESSING 3(2-3) S
Prerequisite: BAE 341

This course deals with the physical and biochemical characteristics of harvested crops and crop products, as they define the requirements for the best preservation of quality. The properties of air-water vapor mixtures, the application of heat to air and crops, the characteristics and use of fans and heaters, the air flow requirements and measurement for crop preservation and materials handling will be studied. Feed preparation, mixing and handling are included in the course.

Mr. Weaver

BAE 453 BIO-ENGINEERING PARAMETERS 2(2-0) F
Prerequisites: BAE 303, BAE 352, MA 301

Physical properties and response characteristics of plant materials are studied in their relationship to engineering analysis for production, harvesting and processing operations. Topics include germination, growth dynamics, physical properties for harvesting and materials handling, biological response criteria, environmental effects, theory of curing and drying, and quality evaluation.

Mr. Johnson

BAE 461 ANALYSIS OF AGRICULTURAL PRODUCTION SYSTEMS 3(3-0) F
Prerequisites: EC 205, MA 201, ST 361

Survey of methods of systems analysis for agricultural engineering students. Intermediate economics analysis, with particular emphasis on farm machinery economics; materials-handling problems; activity network and scheduling problems; techniques of obtaining and processing systems data.

Mr. Link

BAE 462 FUNCTIONAL DESIGN OF FIELD MACHINES 3(2-2) S
Prerequisites: BAE 361, BAE 461, MAE 301, SSC 200

A study of the modern farm tractor and field machines. The emphasis of the

course is on the translation of measurements of biological and physical factors of the agricultural production system into machine specifications that can be effectively converted into production machines by engineers of the manufacturing industry.

Mr. Bowen

BAE 471 SOIL AND WATER CONSERVATION ENGINEERING

3 (2-3) S

Prerequisite: ST 361 or consent of instructor

General aspects of agricultural hydrology, including precipitation, classification of climate, rainfall disposition, methods of estimating runoff and fundamental soil and water relationships will be given. Included also are factors affecting erosion and drainage, irrigation methods and economic aspects of irrigation in the Southeast.

Mr. Wiser

BAE 481 DESIGN OF FARMSTEAD ENGINEERING SYSTEMS

3 (2-3) S

Prerequisites: BAE 453, BAE 461, BAE 491

Application of conditioning principles to provide the required environment for optimum agricultural production is stressed. Environmental requirements imposed by the biological materials in farmstead systems are related to the first principles of physiology. Consideration of labor reduction and replacement of human decisions with control mechanisms are formalized. Environmental requirements, proper arrangement, material flow, equipment selection and control, and estimation of external loads are presented to indicate design procedures for a sound, functional building.

Mr. Young

BAE 491 ELECTROTECHNOLOGY FOR AGRICULTURAL PRODUCTION

3 (2-3) F

Prerequisites: EE 331, EE 332

Principles of operation of sensors and transducers and their use in measuring environmental and physical variables. Typical circuits will be used to illustrate how sensing devices are employed, to illustrate the use of circuit analysis techniques, and to study the operational characteristics. Control circuits with applications of transient analysis for environment control and switching circuits for materials handling systems. Relevant power distribution techniques, wiring codes and power machinery will be studied in relation to agricultural production problems.

Mr. McClure

FOR GRADUATES AND ADVANCED UNDERGRADUATES

BAE 552 INSTRUMENTATION FOR AGRICULTURAL RESEARCH AND PROCESSING

2 (1-3) S

Prerequisites: EE 331, MA 301

Theory and application of primary sensing elements and transducers. Calibration and use of standards. Use of electronic and solid state circuits in amplifiers, recorders and controllers. Special circuits for agricultural processing.

Mr. Splinter

BAE 590 SPECIAL PROBLEMS

Credits Arranged

Prerequisite: Senior or graduate standing

Each student will select a subject on which he will do research and write a technical report on his results. He may choose a subject pertaining to his particular interest in any area of study in biological and agricultural engineering.

Graduate Staff

FOR GRADUATES ONLY

BAE 654 AGRICULTURAL PROCESS ENGINEERING 3(3-0) S
Prerequisite: MA 441

Generalized classical thermodynamics is extended by Onsager's relations to provide a theoretical basis for analyzing the energetics of systems that include life processes. Mr. Johnson

BAE 661 ANALYSIS OF FUNCTION AND DESIGN OF AGRICULTURAL MACHINERY 3(2-3) S
Prerequisite: Consent of instructor

The course attempts to develop those mathematical and analytical techniques and principles found to be essential in the analysis and design of machines and systems which encompass both the biological and the physical domains and their interfaces. Analytical treatment of physical and biological systems and the functional analysis of machine components are studied to bridge the gap between theories and applications. Control systems synthesis and design are treated with emphasis on quantitative dynamic relations between elements and system response using transfer function and computer simulation techniques.

Messrs. Bowen, Huang

BAE 671 (SSC 671) THEORY OF DRAINAGE: SATURATED FLOW 3(3-0) S
Prerequisite: MA 513

Physical concepts and properties of fluids and porous media are discussed in relation to soil water movement. The fundamental laws and equations governing saturated flow in porous media are derived and discussed. Mathematical solutions of steady-state and transient flow equations are analyzed to determine their applicability to drainage problems. Analogs and models of particular drainage problems are considered. Mr. Kriz

BAE 674 (SSC 674) THEORY OF DRAINAGE: UNSATURATED FLOW 3(3-0) F
Prerequisite: BAE 671 or equivalent

Forces involved and theories utilized in saturated flow in porous media are discussed in relation to soil moisture movement. Steady-state and transient unsaturated flow equations for horizontal and vertical moisture movement are developed and solved. The solutions are applied to present-day laboratory and field technology. Molecular diffusion and hydrodynamic dispersion are considered in light of current tracing techniques. Mr. Kriz

BAE 681 ANALYSIS OF FUNCTION AND DESIGN OF FARMSTEAD SYSTEMS 4(4-0) F or S
Prerequisite: BAE 481

A study of the parameters of a farmstead system with economic criteria pertaining to a formal design procedure. Graduate Staff

BAE 695 SEMINAR 1(1-0) FS
Prerequisite: Graduate standing in biological and agricultural engineering

A maximum of two credits is allowed.

Elaboration of the subject areas, techniques and methods peculiar to professional interest through presentations of personal and published works; opportunity for students to present and critically defend, ideas, concepts and inferences. Discussions to point up analytical solutions and analogies between problems in biological and agricultural engineering and other technologies, and to present the relationship of biological and agricultural engineering to the socioeconomic enterprise. Mr. Hassler

BAE 699 RESEARCH IN BIOLOGICAL AND AGRICULTURAL ENGINEERING

Credits Arranged

Prerequisite: Graduate standing in biological and agricultural engineering

A maximum of six credits is allowed toward a master's degree; no limitations on credits for doctorate program.

Performance of a particular investigation of concern to biological and agricultural engineering. The study will begin with the selection of a problem and culminate with the presentation of a thesis.

Graduate Staff

BOTANY

GRADUATE FACULTY

Professor GLENN R. NOGGLE, *Head*

Professors: DONALD B. ANDERSON, ERNEST A. BALL, ERNEST O. BEAL, ROBERT J. DOWNS, HERBERT T. SCOFIELD; *Emeritus Professor:* BERTRAM W. WELLS; *Associate Professors:* ARTHUR W. COOPER, JAMES W. HARDIN, HEINZ SELTMANN, JAMES R. TROYER, RALPH E. WILLIAMSON; *Assistant Professors:* CHARLES E. ANDERSON, ROGER C. FITES, ROYALL T. MOORE, HAROLD E. PATTEE

ASSOCIATE MEMBERS OF THE DEPARTMENT

Professors: CLARENCE L. MCCOMBS, DONALD E. MORELAND; *Associate Professor:* JOSEPH S. KAHN

The Department of Botany offers programs leading to the Master of Botany, Master of Science and Doctor of Philosophy degrees in the areas of plant physiology, ecology, anatomy, morphology, mycology, phycology and systematic botany.

Excellent physical facilities and equipment are available for teaching and research in all phases of the department's program. Greenhouse facilities and field plots are readily accessible. The Phytotron (part of a two-unit phytotron facility in collaboration with Duke University) offers unexcelled opportunities for research in experimental taxonomy, ecology, morphology and anatomy, and plant physiology. The department maintains an electron microscope laboratory equipped with two Siemens electron microscopes. A fine herbarium supports studies in systematics and ecology. The availability in North Carolina of a wide range of habitats with an accompanying diversity of flora provides opportunities for research problems in ecology, mycology, phycology and taxonomy.

Graduate students terminating their work at the master's level will find employment opportunities in state, federal and industrial laboratories and experiment stations. Academic positions are available in junior and community colleges, as well as in four-year colleges. Holders of the Doctor of Philosophy degree will find opportunities for academic positions in colleges and universities, for research positions in federal and state laboratories and experiment stations, and for research and development work with private industrial research institutions.

FOR ADVANCED UNDERGRADUATES**BO 400 PLANT DIVERSITY**

3(2-3) F

Prerequisite: BO 200

A comprehensive survey of the evolutionary diversity and phylogeny of the plant kingdom. Emphasis is placed on the evolutionary trends and the basis for assumed relationships, considering fossils as well as living forms. Some time is spent observing plants in their native habitats, and on a consideration of adaptations to various environments and modes of existence.

BO 403 SYSTEMATIC BOTANY

4(2-4) S

Prerequisite: BS 100

A systematic survey of vascular plants emphasizing field identification, terminology and general evolutionary relationships.

BO 413 INTRODUCTORY PLANT ANATOMY

3(2-4) S

Prerequisite: BO 200 or equivalent

The cells, tissues and organs of plants will be considered from the standpoint of their functions, patterns of differentiation and location. Emphasis will be given to the flowering plants. Students will be expected to develop several micro-technique skills during the laboratory.

BO 414 (ZO 414) CELL BIOLOGY

4(3-3) FS

Prerequisites: CH 223, PY 212

A study of the chemical and physical bases of cellular structure and function with emphasis on methods and interrelationships.

BO 421 PLANT PHYSIOLOGY

4(3-3) FS

Prerequisite: BS 100

Physiology of the green plant emphasizing plant organization, water and solute relationships, organic and inorganic nutrition, growth and development.

BO 442 (ZO 442) GENERAL ECOLOGY

4(3-3) F

Prerequisite: BS 100 or equivalent

The general principles of the interrelationships among organisms and between organisms and their environment—land, fresh-water and marine.

FOR GRADUATES AND ADVANCED UNDERGRADUATES**BO 522 ADVANCED SYSTEMATICS OF ANGIOSPERMS**

4(3-3) F

Prerequisite: BO 403

A comprehensive survey of the systematics and evolution of angiosperm families. Special emphasis is given to detailed morphology, phylogeny and critical identification in the laboratory and field. (Offered 1967-68 and alternate years.)

Mr. Hardin

BO 537 PHYSIOLOGY OF PLANT CELLS

3(3-0) F

Prerequisites: BO 414, or BO 421 and organic chemistry, or consent of instructor

A discussion of physiological processes of plants at the cellular level with emphasis on theoretical principles.

Mr. Troyer

BO 538 LABORATORY IN THE PHYSIOLOGY OF PLANT CELLS

1(0-3) F

Prerequisite or corequisite: BO 537

Selected laboratory exercises to accompany BO 537 Physiology of Plant Cells. Topics will include cytochemistry, plant enzymes, physiology of stomata, plant-water relations, photophysiology and plant growth regulators.

Mr. Troyer

BO 544 PLANT GEOGRAPHY 3(3-0) S
Prerequisites: BO 403, BO 442, GN 411 or equivalents

A course in descriptive and interpretive plant geography, synthesizing data from the fields of ecology, genetics, geography, paleobotany and taxonomy. Includes a survey of the present distribution of major vegetation types throughout the world, a discussion of the history and development of this present pattern of vegetation, and a discussion of the principles and theories of plant geography. (Offered in 1968-69 and alternate years.) Mr. Cooper

BO 545 ADVANCED PLANT ECOLOGY 3(2-3) S
Prerequisites: BO 421, BO 442 or equivalents

An advanced consideration, through class discussions and individual projects, of the principles, theories and methods of plant ecology. (Offered in 1967-68 and alternate years.) Mr. Cooper

BO 555 PLANT CHEMISTRY 3(2-3) S
Prerequisite: BCH 551

Composition of plants; properties, nature and classification of plant constituents; changes occurring during growth, ripening and storage of plant products. Mr. Noggle

BO 574 (MB 574) PHYCOLOGY 3(1-4) S
Prerequisite: BS 100

An introduction to the structure, reproduction and importance of organisms which may be included in the algae. Considerable time is devoted to the local fresh-water and marine floras and the ecology of important species. Mr. Whitford

BO 575 (MB 575, PP 575) THE FUNGI 4(3-3) S
Prerequisite: BO 400 or equivalent

A review of the fungi within the framework of a survey of the major classes. Lectures, while covering the major groups systematically, will also include ancillary material such as aspects of ultrastructure, environmental adaptations, sexuality, ontogeny and economic, including historical, importance. Laboratory sessions will provide for study of both known and unknown material to familiarize the student with the characteristics of the fungi and to develop an appreciation of the problems and methods of their classification. Mr. Moore

BO 590 TOPICAL PROBLEMS 1-3 FS
Prerequisite: Consent of instructor

Discussions and readings on problems of current interest in the fields of ecology, anatomy and morphology, taxonomy and cell biology. May be repeated with change in topic for a maximum of six credits. Graduate Staff

FOR GRADUATES ONLY

BO 612 MORPHOLOGY OF VASCULAR PLANTS 4(3-3) F
Prerequisite: BO 400 or equivalent

Form, reproduction, vegetative structure and phylogeny of the vascular plants. Interpretations based on the current literature. Mr. Ball

BO 613 MICRO AND ULTRASTRUCTURE OF VASCULAR PLANTS 4(3-3) S
 Prerequisite: BO 400 or equivalent

Micro and ultrastructure of cells, tissues and organs of vascular plants.
 Interpretations based on the current literature. Mr. Ball

BO 620 ADVANCED TAXONOMY 3(2-2) F
 Prerequisites: BO 522, consent of instructor

A course in the principles of plant taxonomy including the history of taxonomy, systems of classification, rules of nomenclature, taxonomic literature, taxonomic and biosystematic methods, and monographic techniques. (Offered 1968-69 and alternate years.) Mr. Hardin

BO 632 PLANT NUTRITION 3(3-0) F
 Prerequisites: BO 414 or BO 421, organic chemistry

An advanced course in plant physiology covering the subcellular organization of plants, photosynthesis, inorganic and organic metabolism, and respiration.
 Mr. Noggle

BO 633 PLANT GROWTH AND DEVELOPMENT 3(3-0) S
 Prerequisites: BO 414 or BO 421, organic chemistry

An advanced course in plant physiology covering plant growth, development, differentiation, senescence and biological control mechanisms. Mr. Fites

BO 636 DISCUSSIONS IN PLANT PHYSIOLOGY 1(1-0) FS
 Prerequisites: BO 414 or BO 421, organic chemistry

Group discussions at an advanced level of selected topics of current interest in plant physiology. Graduate Staff

BO 691 BOTANY SEMINAR 1(1-0) FS

Scientific articles, progress reports in research and special problems of interest to botanists are reviewed and discussed. Graduate student credit is allowed if one paper per semester is presented at the seminar. Graduate Staff

BO 693 SPECIAL PROBLEMS IN BOTANY Credits Arranged

Directed research in some specialized phase of botany other than a thesis problem but designed to provide experience and training in research. Graduate Staff

BO 699 RESEARCH Credits Arranged

Original research preliminary to writing a master's thesis or a doctoral dissertation. Graduate Staff

CERAMIC ENGINEERING

(For a listing of graduate faculty and departmental information
 see Mineral Industries, page 199.)

FOR ADVANCED UNDERGRADUATES

MIC 415, 416 CERAMIC ENGINEERING DESIGN 3(1-5) FS
 Prerequisites: EM 301, MIC 306

A two-semester study to encourage creative solutions to problems of current interest and need in the ceramic profession. Discussion of sources of data,

design principles, creativity, optimization, economic value analysis and decision-making. Individual and team study involving interdependence of plant layout, processes, equipment and materials in the design of engineering systems or sub-systems. Study of factors in utilization of ceramics in materials systems.

MIC 430 RESEARCH AND CONTROL METHODS 3(2-3) F
Prerequisite: MIC 306

Interpretation of results, instrumental methods applied to research and product development. Statistical quality control.

MIC 431 REACTION KINETICS IN CERAMIC SYSTEMS 4(3-3) S
Prerequisites: CH 431, MIM 201

A study of reactions taking place during thermal treatment of ceramic systems. Such topics as thermodynamics, heterogeneous phase equilibria, diffusion, solid-state reactions, nucleation and grain growth are treated.

MIC 432 PRINCIPLES OF THE GLASSY PHASE 4(3-3) F
Prerequisite: MIC 431

A study of the glassy state to include the structure, properties and types of glasses (including glazes and enamels). Opacity, color and devitrification. Nature of the glassy phase in kiln-fired ceramics.

MIC 433 CERAMIC MICRO-STRUCTURE AND PROPERTIES 4(3-3) S
Prerequisite: MIC 431

A study of the properties and behavior of processed ceramics from the standpoint of their phase characterization, atomic, micro- and macro-structure. Characteristics of ceramics are interpreted in terms of basic mechanisms affecting thermal, electronic, magnetic, mechanical, optical and nuclear properties. Emphasis is placed on process treatment and environmental effects.

MIC 451 PRINCIPLES OF CERAMIC ENGINEERING 3(3-0) F
Prerequisite: CH 433 or MAE 302 or CHE 315

An advanced treatment of fundamental relationships among ceramic materials, processes and properties. Designed to provide an adequate background for students from other engineering and physical science curricula to permit effective study of ceramic engineering at the graduate level.

MIC 491 SEMINAR 1(1-0) FS

Literature survey of selected topics in ceramic engineering. Oral and written reports, discussions.

FOR GRADUATES AND ADVANCED UNDERGRADUATES

MIC 501, 502 CERAMIC STRUCTURAL ANALYSIS 3(3-0) FS
Prerequisite: GY 331

Basic laws of crystal structures. Arrangements of ions in crystals. Estimation of phases present in multicomponent systems utilizing X-ray techniques. Analysis of glass structure. Correlation of structure with composition and properties.

Mr. Hamme

MIC 503 CERAMIC MICROSCOPY 3(2-3) F
Prerequisite: GY 331

Transmitted and reflected light techniques for the systematic study of ceramic materials and products. Interpretation and representation of results.

Graduate Staff

MIC 506 ELECTRON MICROSCOPY 3(2-3) F
 Prerequisite: MIC 503 or PY 404 or EE 507

The theory of the realization of electrostatic and magnetic lenses for electron microscopy. Major emphasis is placed on interpretation of electron diffraction and surface replications of ceramics and metals
 Graduate Staff

MIC 509 HIGH VACUUM TECHNOLOGY 3(2-3) Sum.
 Prerequisite: CH 433 or MAE 301

Properties of low-pressure gases and vapors. Production, maintenance and measurement of high vacuum; design, construction and operation of high vacuum, high temperature facilities. Properties and reactions of materials which are processed, tested and/or utilized in high vacuum environments. Mr. Palmour

MIC 527 REFRACTORIES IN SERVICE 3(3-0) S
 Prerequisite: CH 433

A study of the physical and chemical properties of the more important refractories in respect to their environment in industrial and laboratory furnaces.
 Mr. Kriegl

MIC 529 PROPERTIES OF HIGH TEMPERATURE MATERIALS 3(3-0) S
 Prerequisite: MIM 201

Effect of temperature on the physical, mechanical and chemical properties of inorganic materials; relationships between micro-structure and high temperature properties; uses of ceramics, cermets and metals at extremely high temperatures.
 Mr. Stoops

MIC 533, 534 ADVANCED CERAMIC ENGINEERING DESIGN 3(2-3) FS
 Prerequisites: MIC 416, MIC 433

Advanced studies in analysis and design of ceramic products, processes and systems leading to original solutions of current industrial problems and the development of new concepts of manufacturing.
 Mr. Palmour

MIC 540 GLASS TECHNOLOGY 3(3-0) F
 Prerequisite: MIC 432

Fundamentals of glass manufacture including compositions, properties and application of the principal types of commercial glasses.
 Mr. Kriegl

MIC 548 TECHNOLOGY OF CEMENTS 3(3-0) S
 Prerequisite: MIC 431

The technology of the Portland cement industry including manufacture, control and uses.
 Mr. Kriegl

MIC 596, 597 ADVANCED CERAMIC EXPERIMENTS 3(1-6) FS
 Prerequisite: MIC 430 or equivalent

Advanced studies in ceramic laboratory experimentation. Graduate Staff

FOR GRADUATES ONLY

MIC 601 CERAMIC PHASE RELATIONSHIPS 3(3-0) S
 Prerequisite: Consent of instructor

Heterogeneous equilibrium, phase transformations, dissociation, fusion, lattice energy, defect structure, thermodynamic properties of ionic phases and silicate melts.
 Graduate Staff

MIC 603 ADVANCED CERAMIC REACTION KINETICS 3(3-0) S
 Prerequisites: MIC 431, MIC 501

Fundamental study of the kinetics of high temperature ceramic reactions such as diffusion, nucleation, grain growth, recrystallization, phase transformation, vitrification and sintering. Mr. Stoops

MIC 611 CERAMIC PROCESS ANALYSIS 3(3-0) F
 Prerequisite: MIC 502
 Corequisite: ST 516

Analysis of experimental and production data for ceramic processes. Quantitative evaluation of the effect of materials, materials preparation, heat distribution, composition and other variables on properties. Sampling from production. Linear programming to compound glass and cement batches.

Graduate Staff

MIC 621 THE VITREOUS STATE 3(3-0) S
 Prerequisite: MIC 540

An advanced study of the structure of binary and ternary silicate and borate glasses. Influence of structure on properties of vitreous systems.

Mr. Manning

MIC 631, 632 ADVANCED PHYSICAL CERAMICS I, II 3(2-3) FS
 Corequisites: MIC 501, MIC 502 or MIM 521, MIM 522, EM 501, EM 502 or PY 503, PY 552

Lattice structures and lattice energies in crystalline ceramics; relationships with elastic, optical and thermal properties. Effects of constitution and micro-structure on lattice-sensitive properties. The defect crystalline state in ceramics; vacancies, color centers, dislocations, boundaries. Crystal growth. Plastic deformation processes, including creep and fatigue; the ductile-brittle transition. Structure-sensitive properties of crystalline, vitreous and composite ceramics; effects of constitution, micro-structure and non-stoichiometry.

Mr. Palmour

MIC 635, 636 ELECTRONIC CERAMICS 3(3-0) Sum.
 Prerequisites: MA 441, PY 407 or PY 414 or EE 531

Lattice energy, dielectric and optical properties of insulators, ferroelectrics, magnetic oxides, electron distribution in insulators and semiconductors; electronic properties of alkali halides.

Mr. Stadelmaier

MIC 695 CERAMIC ENGINEERING SEMINAR 1(1-0) FS

Reports and discussion of special topics in ceramic engineering and allied fields.

Graduate Staff

MIC 697 SPECIAL STUDIES IN CERAMIC ENGINEERING 1-3 per semester

Special studies of advanced topics in ceramic engineering. Credit will vary with the topic. Graduate Staff

MIC 699 CERAMIC RESEARCH Credits Arranged

An original and independent investigation in ceramic engineering. A report of such an investigation is required as a graduate thesis. Graduate Staff

CHEMICAL ENGINEERING

GRADUATE FACULTY

Professor JAMES K. FERRELL, *Head*

Professors: LEONARD G. AUSTIN, KENNETH O. BEATTY, JR., RICHARD BRIGHT, WARREN L. MCCABE, EDWARD M. SCHOENBORN, VIVIAN T. STANNETT; *Associate Professors:* DAVID B. MARSLAND, DONALD C. MARTIN, JOHN F. SEELY, EDWARD P. STAHEL; *Assistant Professor:* HAROLD B. HOPFENBERG

The Department of Chemical Engineering offers programs of advanced study and research leading to the Master of Science and Doctor of Philosophy degrees. The chemical engineering faculty seeks to provide a close association between faculty and students, to promote a common interest in advanced professional study, and to encourage intensive investigation and top-level creative activity.

Graduate work in chemical engineering is of increasing importance since it enables the student to attain a higher degree of specialized competence and at the same time to secure greater mastery of the sciences underlying the quantitative aspects of chemical technology. The demand for chemical engineers with advanced training is greater now than at any time since the beginning of the chemical industry.

Students with one or more years of training beyond the baccalaureate are especially needed for fundamental and applied research, process development and design, production, and even for management, technical service and sales. Consulting work and careers in teaching usually demand a period of advanced study well beyond the normal four-year undergraduate program.

Students entering graduate work in chemical engineering should have a bachelor's degree in chemical engineering or its equivalent. Programs can be worked out to accommodate students with bachelor's degrees in chemistry, physics and other branches of engineering.

At present, major emphasis in the department is concerned with basic studies of unit operations such as fluid dynamics, heat transfer, boiling heat transfer and two-phase flow, mass transfer, distillation, solvent extraction and crystallization. These are supported by programs in thermodynamics, reaction kinetics, phase equilibria and process measurement and control. The department has also recently developed strong research programs in polymer science and in electrochemical engineering and powder technology. The varied interests of an exceptionally well-qualified staff provide guidance for advanced study in any phase of chemical engineering. Strong supporting programs are available in mathematics, statistics, physics, chemistry, nuclear engineering, metallurgy, the life sciences, textiles and other fields of engineering.

The Department of Chemical Engineering occupies the four-story east wing of the Riddick Engineering Laboratories Building. Modern, well-equipped laboratories are provided with all necessary services for both teaching and research. A wide variety of special facilities such as analog and digital computers, X-ray equipment, spectrophotometers, electron microscope, electromechanical testing machine, electronic controllers and recorders are available for graduate research.

Members of the chemical engineering staff conduct a number of important research projects which are supported by industry, state and federal agencies. Graduate students assisting on these projects not only acquire financial assistance but gain valuable research experience on problems of current interest.

In addition to research assistantships, the department offers each year a number of graduate assistantships for part-time work in the department. These may be for teaching, laboratory preparation or research, as the need arises. Appointments are for one academic year of nine months for half-time work and, at present, carry a stipend of \$2,700 renewable upon evidence of satisfactory performance. Summer work is also available.

FOR ADVANCED UNDERGRADUATES

CHE 421, 422 REACTOR ENERGY TRANSFER I, II 3(3-0) FS
Prerequisites: MA 202, PY 208

Thermodynamics, heat transfer and fluid flow with emphasis on the problems and methods used in the design and analysis of nuclear reactors.

CHE 425 PROCESS MEASUREMENT AND CONTROL 4(3-2) F
Prerequisite: CHE 312

Theory and application of methods for measuring, recording, transmitting and controlling process variables. The techniques of analysis, beginning with process elements in automatic control and proceeding through systems analysis, are employed. Analog and digital computers are used in the study and solution of problems.

CHE 427, 428 SEPARATION PROCESSES I, II 3(3-0) FS
Prerequisite: CHE 311

A study of the principles underlying such unit operations as absorption, extraction, distillation, drying, filtration, etc., with emphasis on procedures and economic considerations.

CHE 431 CHEMICAL ENGINEERING LABORATORY I 3(1-5) S
Prerequisite: CHE 311

Laboratory work on typical apparatus involving unit operations. Experiments are designed to augment the theory and data of lecture courses and to develop proficiency in the writing of technical reports.

CHE 432 CHEMICAL ENGINEERING LABORATORY II 3(1-5) FS
Prerequisite: CHE 312

A continuation of CHE 431.

CHE 433 CHEMICAL ENGINEERING LABORATORY III 3(1-5) FS
Prerequisite: CHE 427

A continuation of CHE 432.

CHE 446 CHEMICAL PROCESS KINETICS 3(3-0) S
Prerequisite: CHE 315

A basic study of homogeneous and heterogeneous chemical reactions, and of catalysis.

CHE 495 SEMINAR 1(1-0) FS

Professional aspects of chemical engineering; topics of current interest in chemical engineering.

CHE 497 CHEMICAL ENGINEERING PROJECTS 2(0-6) F S

Introduction to research through experimental, theoretical and literature studies of chemical engineering problems. Oral and written presentation of reports.

FOR GRADUATES AND ADVANCED UNDERGRADUATES**CHE 511 PROBLEM ANALYSIS FOR CHEMICAL ENGINEERS 3(3-0) S**

Prerequisites: CHE 428, MA 301

The application of the methods of mathematical analysis to the formulation and solution of problems in transport phenomena, transient phenomena in unit operations, process dynamics and thermodynamics. Study and use of analog computer solutions of these problems.

Mr. Ferrell

CHE 513 THERMODYNAMICS I 3(3-0) F

Prerequisite: CH 315 or equivalent

An intermediate course in thermodynamic principles and their application to chemical and phase equilibria. The course is largely from a macroscopic viewpoint but consideration will be given to some aspects of the statistical viewpoint

Mr. Beatty

CHE 515 TRANSPORT PHENOMENA 3(3-0) S

Prerequisite: CHE 312

A theoretical study of transport of momentum, energy and matter with emphasis on the latter two. The diffusional operations, including coupled heat and mass transfer, are introduced in the light of the theory.

Mr. Marsland

CHE 517 KINETICS AND CATALYSIS 3(3-0) F

Prerequisite: CHE 446

An intensive study of homogeneous and heterogeneous kinetic reactions. Emphasis will be placed on fundamental approaches, experimental methods and mathematical techniques in engineering analysis of chemical reaction systems.

Mr. Stahel

CHE 540 ELECTROCHEMICAL ENGINEERING 3(3-0) S

Prerequisite: Physical chemistry

The application of electrochemical principles to such topics as electrolysis, electroanalysis, electroplating and metal refining.

Mr. Austin

CHE 541 CELLULOSE INDUSTRIES 3(3-0) F

Prerequisite: Organic chemistry

Methods of manufacture and application of cellulose chemical conversion products. Emphasis placed on recent developments in the field of synthetic fibers, films, lacquers and other cellulose compounds.

Mr. Seely

CHE 543 TECHNOLOGY OF PLASTICS 3(3-0) S

Prerequisite: Organic chemistry

The properties, methods of manufacture and applications of synthetic resins. Recent developments in the field are stressed.

Mr. Seely

CHE 551 THERMAL PROBLEMS IN NUCLEAR ENGINEERING 3(3-0) S
 Prerequisite: MAE 302 or MAE 303, or CHE 311, or equivalent

The design and operation of nuclear reactors and the utilization of the power from them involves major problems in nearly every phase of heat transfer, and many important problems in fluid flow. Possible solutions to these problems are severely affected by the influences of radiation on heat transfer media, hazards of handling radioactive substances, etc. The course considers the thermal problems of nuclear reactor design and the principles of fluid flow and heat transfer necessary to their solutions. The course is intended for engineers and science students with backgrounds in physics, mathematics and elementary thermodynamics.

Mr. Beatty

CHE 597 CHEMICAL ENGINEERING PROJECTS 1-3 FS
 Prerequisite or corequisite: CHE 412

A laboratory study of some phase of chemical engineering or allied field.
 Graduate Staff

FOR GRADUATES ONLY

CHE 610 HEAT TRANSFER 3(3-0) F
 Prerequisite: CHE 515

An advanced course dealing primarily with heat transfer between liquids and solids, optimum operating conditions and design of equipment, conduction, heating and cooling of solids, radiant heat transmission.

Mr. Beatty

CHE 621 MASS-TRANSFER OPERATIONS 3(3-0) F
 Prerequisite: CHE 515

Application of transport theory and empirical devices to the analysis, synthesis and design of mass-transfer equipment. The operations of absorption, extraction, distillation, humidification and drying will be considered.

Mr. Marsland

CHE 622 CHEMICAL REACTION ENGINEERING 3(3-0) S
 Prerequisite: CHE 517

An advanced study of ideal and real reactor systems. The approach employed is twofold: characterization of actual systems by empirical rate expressions coupled with fundamental analysis; simulation of coupled physical and chemical processes in a reactor by solution of various types of physical models.

Mr. Stahel

CHE 623 FLUID AND PARTICLE DYNAMICS 3(3-0) S
 Prerequisite: CHE 515

The principles of fluid dynamics and their application to laminar and turbulent flow, flow in closed channels, flow in packed beds and porous media, particle technology, industrial rheology and two-phase flow.

Mr. Ferrell

CHE 624 PROCESS DYNAMICS 3(3-0) F
 Prerequisite: CHE 511

A detailed study of the dynamic response of typical chemical process equipment including instrumentation and process control devices. Fundamental concepts of automatic control of process variables such as temperature, pressure flow and liquid level.

Mr. Martin

CHE 625 THERMODYNAMICS II 3(3-0) F
 Prerequisite: CHE 513

A consideration of various thermodynamic topics of special interest to chemical

engineers. The effects of high pressures and high temperatures on equilibria, relationship of thermodynamics to rate process, thermodynamics of the steady state including coupled transfer process and experimental methods in thermodynamics would be typical. Mr. Beatty

CHE 631 CHEMICAL PROCESS DESIGN 3(3-0) S
Prerequisite: CHE 428

Design and selection of process equipment, through solution of comprehensive problems involving unit operations, kinetics, thermodynamics, strength of materials and chemistry. Graduate Staff

CHE 671 (TC 671) SPECIAL TOPICS IN POLYMER SCIENCE 1-3 F
(See Textile Chemistry, page 245.)

CHE 690 READINGS IN CHEMICAL ENGINEERING Credits Arranged FS

A comprehensive survey of the literature in a specified area, and an exhaustive survey on a chosen topic within that area, under the direct guidance of the thesis advisor. This course has the goals of (a) mature selection of a research topic, and (b) preparation for a research proposal in fullest possible detail. Graduate Staff

CHE 693 ADVANCED TOPICS IN CHEMICAL ENGINEERING 1-3 FS

A study of recent developments in chemical engineering theory and practice, such as ion exchange, crystallization, mixing, molecular distillation, hydrogenation, fluorination. The topic will vary from term to term. Graduate Staff

CHE 695 SEMINAR 1(1-0) FS

Literature investigations and reports of special topics in chemical engineering and allied fields. Graduate Staff

CHE 699 RESEARCH Credits Arranged FS

Independent investigation of an advanced chemical engineering problem. A report of such an investigation is required as a graduate thesis. Graduate Staff

CHEMISTRY

GRADUATE FACULTY

Professor Z ZIMMERMAN HUGUS, JR., *Head*

Professors: GEORGE O. DOAK, CARL L. BUMGARDNER, DAVID M. CATES, LEON D. FREEDMAN, RICHARD H. LOEPFERT, *Assistant Head*, WALTER J. PETERSON, WILLIS A. REID, HENRY A. RUTHERFORD, PAUL P. SUTTON, RAYMOND C. WHITE; *Adjunct Professor:* MONROE E. WALL; *Associate Professors:* LAWRENCE H. BOWEN, ALONZO F. COOTS, FORREST W. GETZEN, CHESTER E. GLEIT, FORREST C. HENTZ, JR., LOUIS A. JONES, SAMUEL G. LEVINE, G. GILBERT LONG, *Graduate Administrator*, WILLIAM P. TUCKER; *Assistant Professors:* HALBERT H. CARMICHAEL, M. KEITH DEARMOND, MARION L. MILES, CHARLES G. MORELAND, GEORGE H. WAHL, JR.; *Instructor:* THOMAS M. WARD

The Department of Chemistry offers the degrees of Master of Science and Doctor of Philosophy. Students may major in analytical, inorganic, organic or physical chemistry.

A student entering into graduate work in chemistry should have a

bachelor's degree in chemistry or its equivalent. Minimum course requirements include the equivalent of four basic year courses in general, organic, physical and analytical chemistry, and semester courses in inorganic chemistry and qualitative organic analysis. At least one year of college physics and two years of mathematics, including differential equations, are also required. Students who fail to meet the requirements may in some cases be admitted on a provisional basis.

Some areas of active research in which thesis work may be done include organic and inorganic syntheses, structure and properties of organometallic compounds and transition metal complexes, stereochemistry of natural and synthetic compounds, kinetics and mechanisms of reactions, radiochemistry, tracer studies, micro-analysis, polymer and fiber chemistry, and infrared and nuclear magnetic resonance spectroscopy.

The department is well equipped with standard instruments and apparatus for research and teaching. Many items of specialized equipment are available, including recording spectrophotometers covering the range from far infrared to ultraviolet, a Varian HA-100 nuclear magnetic resonance spectrometer, temperature-programmed and preparative gas chromatographs, automatic fraction collectors, refrigerated centrifuges, an automatic C, H, N analyzer, micro-balances, Mossbauer effect apparatus and a hydrogen cryostat. The department has particularly well-equipped spectrographic and radiochemical laboratories.

Teaching and research assistantships and fellowships are available for qualified applicants.

FOR ADVANCED UNDERGRADUATES

CH 401 SYSTEMATIC INORGANIC CHEMISTRY 3(3-0) S
Corequisite: CH 433

A survey of the chemical elements based on atomic structure and the periodic system, also introducing newer concepts of structure and symmetry. A knowledge of basic physical chemical principles is prerequisite.

CH 411 ANALYTICAL CHEMISTRY I 4(2-6) F
Prerequisites: CH 431, CH 432
Corequisite: CH 433

An introduction to analytical chemistry, including the design, execution and interpretation of quantitative chemical measurements. Chromatographic, gravimetric and related techniques of separation are presented.

CH 413 ANALYTICAL CHEMISTRY II 4(2-6) S
Prerequisite: CH 411

Methods of quantitative analysis based on solution chemistry, electrochemistry and the interactions of radiation with matter. Specific topics include acid-base, potentiometric and coulometric titrations and absorption spectroscopy.

CH 428 QUALITATIVE ORGANIC ANALYSIS 3(1-6) FS
Prerequisite: CH 223

An introduction to the identification of organic compounds by means of physical properties (including infrared spectra), chemical classification tests and preparation of derivatives.

CH 431 PHYSICAL CHEMISTRY I 3(3-0) FS
 Prerequisites: CH 107, MA 202, PY 207 or PY 208
 Corequisite: MA 301

CH 431, 433, 435 provide an intensive study of physical chemical principles. CH 431 emphasizes states of matter, thermodynamics and physical and chemical equilibrium.

CH 432 PHYSICAL CHEMISTRY I LABORATORY 1(0-3) F
 Corequisite: CH 431

Laboratory course to accompany the lecture work in CH 431.

CH 433 PHYSICAL CHEMISTRY II 3(3-0) FS
 Prerequisites: CH 431, MA 301

A continuation of CH 431, emphasizing properties of solutions, electrochemistry and reaction kinetics.

CH 434 PHYSICAL CHEMISTRY II LABORATORY 1(0-3) S
 Corequisite: CH 433

Laboratory course to accompany the lecture work in CH 433.

CH 435 PHYSICAL CHEMISTRY III 3(3-0) F
 Prerequisites: CH 431, MA 301

A continuation of CH 431 emphasizing molecular structure and chemical bonding.

CH 441 COLLOID CHEMISTRY 3(2-3) S
 Prerequisites: CH 215, CH 220

Adsorption; preparation, properties, constitution, stability and application of sols, gels, emulsions, foams and aerosols; dialysis; Donnan membrane equilibrium.

CH 490 CHEMICAL PREPARATIONS 3(1-6) FS
 Prerequisite: Three years of chemistry

Lectures and laboratory work in preparative chemistry. Synthetic procedures will be selected to illustrate advanced methods and techniques in both inorganic and organic chemistry.

CH 491 READING IN HONORS CHEMISTRY 2-6 FS
 Prerequisite: Three years of chemistry

A reading course for exceptionally able students at the senior level. The students will do extensive reading in areas of advanced chemistry and will present written reports of their findings.

CH 493 CHEMICAL LITERATURE 1(1-0) F
 Prerequisite: Three years of chemistry

A systematic introduction to the location and retrieval of information required for the solution of chemical problems.

CH 499 SENIOR RESEARCH 1-3 FS
 Prerequisite: Three years of chemistry

An introduction to research. Independent investigation of a research problem under the supervision of a member of the chemistry faculty.

FOR GRADUATES AND ADVANCED UNDERGRADUATES

CH 501 INORGANIC CHEMISTRY I

3(3-0) F

Prerequisite: CH 433

Modern inorganic chemistry from the point of view of the chemical bond. Chemical periodicity and its origins in atomic structure, the ionic bond and electronegativity, crystal structure and bonding in ionic solids, the metallic state, conduction and semiconductors, and the preparation and properties of illustrative compounds.

Mr. Long

CH 503 INORGANIC CHEMISTRY II

3(3-0) S

Prerequisite: CH 501

The hydrogen molecule-ion and the theory of the covalent bond, molecular orbitals and hybridization, dipole moments and magnetic properties, the theory of acids and bases, nonaqueous solvents, coordination compounds, carbonyl and quasisaromatic compounds, and the chemistry of the transition metals, lanthanides and actinides.

Mr. Long

CH 511 CHEMICAL SPECTROSCOPY

3(2-3) F

Prerequisite: CH 433

Theory, analytical applications and interpretation of spectra as applied to chemical problems. Major emphasis will be placed upon ultraviolet, visible and infrared spectra.

Mr. DeArmond

CH 521 ADVANCED ORGANIC CHEMISTRY I

3(3-0) F

Prerequisites: CH 223, CH 433 or CH 435

Structure, stereochemistry and reactions of the various classes of hydrocarbons. The molecular orbital treatment of bonding and reactivity of alkenes, the conformational interpretation of cycloalkane and cycloalkene reactivity and the application of optical isomerism to the study of reaction mechanisms will be emphasized.

Mr. Wahl

CH 523 ADVANCED ORGANIC CHEMISTRY II

3(3-0) S

Prerequisite: CH 521

An introduction to acid-base theory and mechanistic organic chemistry as applied to synthetically useful organic reactions.

Mr. Miles

CH 525 PHYSICAL METHODS IN ORGANIC CHEMISTRY

3(3-0) F

Prerequisites: CH 223, CH 433 or CH 435

Application of physical methods to the solution of structural problems in organic chemistry. Emphasis will be on spectral methods including infrared, ultraviolet, nuclear magnetic resonance, mass spectrometry, electron paramagnetic resonance, X-ray and electron diffraction and optical rotatory dispersion.

Graduate Staff

CH 531 CHEMICAL THERMODYNAMICS

3(3-0) F

Prerequisites: CH 433, MA 301

An extension of elementary principles to the treatment of ideal and real gases, ideal solutions, electrolytic solutions, galvanic cells, surface systems and irreversible processes. An introduction to statistical thermodynamics and the estimation of thermodynamic functions from spectroscopic data.

Mr. Sutton

CH 533 CHEMICAL KINETICS

3(3-0) S

Prerequisites: CH 433, MA 301

An intensive survey of the basic principles of chemical kinetics with emphasis

on experimental and mathematical techniques, elements of the kinetic theory and theory of the transition state. Applications to gas reactions, reactions in solution and mechanism studies. Messrs. Bowen, Carmichael

CH 535 SURFACE PHENOMENA 3 (3-0) F
Prerequisites: CH 433, MA 301

An intensive survey of the topics of current interest in surface phenomena. Formulations of basic theories are presented together with illustrations of their current applications. Mr. Getzen

CH 537 QUANTUM CHEMISTRY 3 (3-0) S
Prerequisites: MA 301, CH 433 or PY 407

The elements of wave mechanics applied to stationary energy states and time dependent phenomena. Applications of quantum theory to chemistry, particularly chemical bonds. Mr. Coots

CH 545 RADIOCHEMISTRY 3 (2-3) S
Prerequisite: PY 410

The applications of radioactivity to chemistry and the applications of chemistry to the radioactive elements, particularly the transuranium elements and fission products. Mr. Coots

CH 562 (TC 562) PHYSICAL CHEMISTRY OF HIGH POLYMERS-BULK PROPERTIES 3 (3-0) S
(See Textile Chemistry, page 245.)

FOR GRADUATES ONLY

CH 623 VALENCE AND THE STRUCTURE OF ORGANIC MOLECULES 3 (3-0) F
Prerequisites: CH 523, CH 433

Applications of molecular orbital theory, thermodynamics and free energy relations to organic problems. Mr. Jones

CH 625 ORGANIC REACTION MECHANISMS 3 (3-0) S
Prerequisites: CH 523, CH 433

A study of the effects of structure and substituents on the direction and rates of organic reactions. Mr. Bumgardner

CH 627 CHEMISTRY OF METAL-ORGANIC COMPOUNDS 3 (3-0) F
Prerequisite: CH 521

Preparation, properties and reactions of compounds containing the carbon-metal bond, with a brief description of their uses. Messrs. Doak, Freedman

CH 631 CHEMICAL THERMODYNAMICS II 3 (3-0) S
Prerequisite: CH 531

Statistical interpretation of thermodynamics; use of partition functions; introduction to quantum statistics; application of statistical mechanics to chemical problems, including calculation of thermodynamic properties, equilibria and rate processes. Messrs. Bowen, Sutton

CH 659 (BCH 659) NATURAL PRODUCTS 3 (3-0) F
Prerequisite: CH 523, CH 525 or consent of instructor

Illustrative studies of structure determination, synthesis and biosynthesis of natural substances. Modern physical methods and fundamental chemical concepts

are stressed. Examples are chosen from such classes as alkaloids, terpenes, steroids and antibiotics. Mr. Levine

CH 691 SEMINAR

1(1-0) FS

Prerequisite: Graduate standing in chemistry

Scientific articles, progress reports in research and special problems of interest to chemists are reviewed and discussed. Graduate Staff

CH 693 ADVANCED TOPICS IN PHYSICAL CHEMISTRY

3(3-0) FS

Prerequisites: Two of the following: CH 531, CH 533, CH 535, CH 537

An intensive treatment of selected topics of importance in current physical chemical research. Graduate Staff

CH 695 SPECIAL TOPICS IN CHEMISTRY

Maximum 3 FS

Prerequisite: Consent of head of department

Critical study of special problems in one of the branches of chemistry. Graduate Staff

CH 699 CHEMICAL RESEARCH

Credits Arranged FS

Prerequisite: Graduate standing in chemistry

Special problems that will furnish material for a thesis. A maximum of six semester credits is allowed toward a master's degree; there is no limitation on credits in the doctorate program. Graduate Staff

CIVIL ENGINEERING

GRADUATE FACULTY

Professor DONALD L. DEAN, Head

Professors: PAUL Z. ZIA, Associate Head, CHARLES R. BRAMER, PAUL D. CRIBBINS, RALPH E. FADUM, ABDEL-AZIZ I. KASHEF, CARROLL L. MANN, JR., CHARLES SMALLWOOD, JR., Graduate Administrator, MEHMET E. UYANIK; Associate Professors: MICHAEL AMEIN, JOHN F. ELY, CHARLES P. FISHER, CLINTON L. HEIMBACH, JOHN W. HORN, LEONARD J. LANGFELDER, WESLEY G. MULLEN, HARVEY E. WAHLS; Assistant Professors: WILLIAM S. GALLER, JEHangir F. MIRZA; Adjunct Assistant Professor: DONALD R. JOHNSTON; Visiting Scholar: MASANOBU SHINOZUKA

The Department of Civil Engineering offers programs of study leading to Master of Science and Doctor of Philosophy degrees. Students may major in soil mechanics and foundation engineering, structural engineering, transportation engineering or sanitary and water resources engineering.

The basic objective of graduate study in civil engineering is to provide the student the knowledge and skills essential to a successful career in a variety of activities such as teaching, research, development and advanced design. In addition to the formal course work, the student is brought into close contact with the graduate faculty through participation in research projects.

The department is actively engaged in a broad area of research in which a student may undertake his thesis work. The current research activities of the department include investigations in structural theories, both deterministic and probabilistic; continuum and discrete field mechanics; limit

analysis and design in metal and in structural concrete; structural models; structural dynamics; plate and shell theory and design; soil dynamics; fundamental behavior of soils; highway safety; traffic flow theory; land use and urban planning; hydraulics and hydrology; waste disposal and pollution control. Many of these investigations are sponsored by industries, federal and state agencies including the continuing North Carolina Cooperative Highway Research Program.

The department is housed in a new air-conditioned building with adequate office and laboratory spaces assigned to graduate students for study and research. The various laboratories of the department are well equipped with standard instruments and apparatus for research and teaching. In addition, there are several specialized facilities including a large universal structural test floor; a fatigue machine with programmed repeated loading; a Hele-Shaw apparatus for study of salt-water intrusion; facilities for chemical and biological research; a wave generator for research in coastal wave motion; a test vehicle equipped with drivometer and speed-and-delay recorder for measuring driver and vehicle performance in highway safety research; facilities for airphoto interpretation and photogrammetry; a resonant column apparatus used in conjunction with the triaxial equipment for the study of dynamic properties of soils; and gyratory equipment for the study of compaction of soils and bituminous materials.

The department cooperates with other divisions of the Consolidated University in a number of joint programs. Qualified students may schedule their courses in this department and in the Department of City and Regional Planning at the University of North Carolina at Chapel Hill to receive a dual degree in Master of Science with major in transportation engineering and Master of Regional Planning. Multidisciplinary study and research programs are also available through the North Carolina Highway Safety Research Institute, Water Resources Research Institute and the Coastal Studies Institute. The department is also engaged in the interdisciplinary research programs in mechanics and materials as the result of a National Science Foundation Science Development Program grant.

Students in other disciplines also find opportunities for developing minor areas of study within the framework of course offerings of the department. In particular, courses of instruction in stream sanitation and industrial waste disposal provide the types of training in pollution control often in great demand by industry.

A brochure and supplementary information, describing in greater detail the opportunities for graduate study and research in the Department of Civil Engineering, are available upon request from the head of the department.

FOR ADVANCED UNDERGRADUATES

CE 405, 406 TRANSPORTATION ENGINEERING I, II 4(3-2) FS
Prerequisites: CE 201 for CE 405; CE 342 for CE 406

An integrated approach to the planning, design and operation of transportation systems. Engineering and economic aspects of the basic transport modes, including highway, rail, water and air facilities, are investigated from the viewpoint of the civil engineer.

CE 421 STRUCTURAL DESIGN I 3(2-3) F
Prerequisites: CE 324, EM 301

An introduction to basic concepts of structural design. Elastic and inelastic analysis and design of structural members and connections in metal. Application of the principles in a design project of metal structure.

CE 422 STRUCTURAL DESIGN IIA 3(2-3) S
Prerequisites: CE 332, CE 421, CE 425

Principles of design and analysis of reinforced concrete members with emphasis on the ultimate strength theory. Application of the principles in a design project of a reinforced concrete structure.

CE 425 STRUCTURAL ANALYSIS II 3(2-3) F
Prerequisites: CE 324, EM 301

A treatment of classical theories of indeterminate structural analysis with an introduction to relaxation and matrix methods, and nonlinear analysis.

CE 429 STRUCTURAL DESIGN IIB 3(2-3) S
Prerequisites: CE 332, CE 421

Principles of structural design in reinforced concrete and timber with application to a design project including construction falsework.

CE 443 FOUNDATIONS 3(3-0) S
Corequisite: CE 422 or CE 429

Identification and classification of soils; geological aspects of foundation engineering; methods of investigating subsoil conditions; control of water; types of foundations; legal aspects of foundation engineering.

CE 461 PROJECT PLANNING AND CONTROL I 3(2-3) F
Prerequisite: CE 362

Project costs and estimates; analysis of construction plant layout requirements and performance characteristics of equipment.

CE 462 PROJECT PLANNING AND CONTROL II 3(2-3) S
Prerequisite: CE 461

Scheduling, analysis and control of construction projects, including critical path techniques.

CE 464 LEGAL ASPECTS OF CONTRACTING 3(3-0) S
Prerequisite: Senior standing

Legal aspects of construction contract documents and specifications; owner-engineer-contractor relationships and responsibilities; bids and contract performance; labor laws.

CE 483 WATER RESOURCES ENGINEERING I 3(3-0) F
Prerequisite: CE 382

The hydrological cycle is studied with particular emphasis on those phases that are of engineering significance. The occurrence and distribution of water; rainfall, runoff, ground water. The development and control of water resources.

CE 484 WATER RESOURCES ENGINEERING II 3(3-0) S
Prerequisite: CE 483

A synthesis of mechanics, chemistry and hydrology in the design of elements of water resources systems. Water supply, treatment and distribution. Waste

water collection, treatment and disposal. Consideration of flood control and stream flow regulation.

CE 485 APPLIED HYDRAULICS 3(3-0) F
Prerequisite: EM 303

Elements of fluid mechanics, hydraulics and hydrology, with application to problems in construction engineering.

CE 487 (GY 487, OC 487) PHYSICAL OCEANOGRAPHY 3(3-0) S
(See Geosciences, page 154.)

FOR GRADUATES AND ADVANCED UNDERGRADUATES

CE 507 AIRPHOTO ANALYSIS I 3(2-3) FS
Prerequisite: Junior standing

Principles and concepts for engineering evaluation of aerial photographs, including analysis of soils and surface drainage characteristics. Mr. Wahls

CE 508 AIRPHOTO ANALYSIS II 3(2-3) S
Prerequisite: CE 507

Continuation of CE 507 with applications to highway and airport projects. Mr. Wahls

CE 509 PHOTOGRAMMETRY 3(2-3) F
Prerequisite: CE 201

Elements of aerial photogrammetry as applied to civil engineering, surveying and mapping, geometry of aerial photographs, flight planning for aerial photography and stereoscopic plotter instruments, especially the Kelsh Plotter. Mr. Wahls

CE 514 MUNICIPAL ENGINEERING PROJECTS 3(2-3) S
Prerequisite: Senior standing

Special problems relating to public works, public utilities, urban planning and city engineering. Messrs. Horn, Smallwood

CE 515 TRANSPORTATION OPERATIONS 3(3-0) F
Prerequisite: CE 406

The analysis of traffic and transportation engineering operations. Messrs. Heimbach, Horn

CE 516 TRANSPORTATION DESIGN 3(2-3) S
Prerequisite: CE 406

The geometric elements of traffic and transportation engineering design. Messrs. Cribbins, Horn

CE 517 WATER TRANSPORTATION 3(3-0) F
Prerequisite: CE 405

The planning, design, construction and operation of waterways, ports, harbors and related facilities. Development of analytical techniques for evaluating the feasibility of piers, ports and multipurpose river basin projects. The design of marine structures and civil works that are significant in civil engineering, including locks, dams, harbors, ports, and contractive and protective works.

Mr. Cribbins

CE 524 ANALYSIS AND DESIGN OF MASONRY STRUCTURES 3(3-0) F
 Corequisite: CE 425

Theory and design of masonry arches, culverts, dams, foundations and masonry walls subjected to lateral loads.
 Messrs. Bramer, Mirza

CE 525, 526 ADVANCED STRUCTURAL ANALYSIS I, II 3(3-0) FS
 Prerequisite: CE 425

A study in depth of classical structural theories, including generalized stiffness and flexibility methods. Treatment of secondary stresses and highrise structures.
 Messrs. Bramer, Dean

CE 527 NUMERICAL METHODS IN STRUCTURAL ANALYSIS 3(3-0) F
 Prerequisites: CE 425, consent of instructor

Numerical solution of problems in structural mechanics, including matrix operations, relaxation, iteration, numerical integration, finite difference and finite element methods.
 Mr. Ely

CE 531 EXPERIMENTAL STRESS ANALYSIS 3(2-3) F
 Prerequisites: CE 425, consent of instructor

Theoretical and experimental techniques for the analysis of strain and stress including mechanical and electrical strain gages, brittle coating, grid method and an introduction to photoelasticity. Structural analysis by indirect and direct models.
 Messrs. Bramer, Mirza, Zia

CE 534 PLASTIC ANALYSIS AND DESIGN 3(3-0) S
 Prerequisite: CE 421

Theory of plastic behavior of steel structures; concept of design for ultimate load and the use of load factors. Analysis and design of components of steel frames including bracings and connections.
 Mr. Bramer

CE 536 THEORY AND DESIGN OF PRESTRESSED CONCRETE 3(3-0) F
 Prerequisite: CE 422

The principles and concepts of design in prestressed concrete including elastic and ultimate strength analyses for flexural, shear, bond and deflection. Principles of concordancy and linear transformation for indeterminate prestressed structures. Application of prestressing to tanks and shells.
 Messrs. Mirza, Zia

CE 544 FOUNDATION ENGINEERING 3(3-0) S
 Prerequisite: CE 342

Subsoil investigations; excavations; design of sheeting and bracing systems; control of water; footing, grillage and pile foundations; caisson and cofferdam methods of construction.
 Messrs. Kashef, Langfelder

CE 547 FUNDAMENTALS OF SOIL MECHANICS 3(3-0) FS
 Prerequisite: EM 301

Physical and mechanical properties of soils governing their use for engineering purposes; stress relations and applications to a variety of fundamental problems.
 Mr. Wahls

CE 548 ENGINEERING PROPERTIES OF SOILS I 3(2-3) F
 Prerequisite: CE 342

The study of soil properties that are significant in earthwork engineering, including properties of soil solids, basic physicochemical concepts, classification, identification, plasticity, permeability, capillarity and stabilization. Laboratory work includes classification, permeability and compaction tests.

Messrs. Kashef, Langfelder

CE 549 ENGINEERING PROPERTIES OF SOILS II 3(2-3) S
Prerequisite: CE 548

Continuation of CE 548, including the study of compressibility, stress-strain relations and shear strength theories for soil. Laboratory work includes consolidation and shear strength tests. Mr. Langfelder

CE 570 (MB 570) SANITARY MICROBIOLOGY 3(2-3) S
Prerequisite: MB 401 or equivalent

Fundamental aspects of microbiology and biochemistry are presented and related to problems of stream pollution, refuse disposal and biological treatment. Laboratory exercises present basic microbiological techniques and illustrate from a chemical viewpoint some of the basic microbial aspects of waste disposal.

Mr. Smallwood

CE 571 THEORY OF WATER AND WASTE TREATMENT 3(3-0) F
Prerequisite: Graduate standing

Study of the physical, chemical and biological principles underlying water and waste treatment processes; including diffusion of gases, solubility, equilibrium and ionization, aerobic and anaerobic stabilization processes, sludge conditioning and disposal. Mr. Galler

CE 572 UNIT OPERATIONS AND PROCESSES IN WASTES ENGINEERING 3(1-6) S
Prerequisite: CE 571

Processes and operations in wastes engineering; including sedimentation, coagulation, filtration, adsorption, biological treatments, softening and new developments. Mr. Smallwood

CE 573 ANALYSIS OF WATER AND WASTES 3(1-6) F
Corequisite: CE 571

Chemical and physical analysis of water and wastes and interpretation of results. Messrs. Galler, Smallwood

CE 574 RADIOACTIVE WASTE DISPOSAL 3(2-3) FS
Prerequisite: PY 407

Unit operations and processes employed in treatment and disposal of radioactive wastes. Mr. Smallwood

CE 575 CIVIL ENGINEERING SYSTEMS 3(3-0) S
Prerequisite: MA 405

An examination of civil engineering systems and their design optimization. The systems to be studied include water resources engineering, structural engineering, transportation engineering and construction. Mr. Galler

CE 580 FLOW IN OPEN CHANNELS 3(3-0) FS
Prerequisite: CE 483

The theory and applications of flow in open channels, including dimensional analysis, momentum-energy principle, gradually varied flow, high-velocity flow, energy dissipators, spillways, waves, channel transitions and model studies.

Mr. Amein

CE 581 INTRODUCTION TO OCEANOGRAPHIC ENGINEERING 3(3-0) F
Prerequisites: EM 303, consent of instructor

A rigorous treatment of the engineering aspects of physical oceanography. The theory for the propagation of waves, methods of wave forecasting and the analysis of wave spectra are presented. The applications of physical oceanography to the design of marine and coastal installations are shown. Mr. Amein

- CE 591, 592 CIVIL ENGINEERING SEMINAR 1(1-0) FS
Discussions and reports of subjects in civil engineering and allied fields.
Graduate Staff
- CE 598 CIVIL ENGINEERING PROJECTS 1-6 FS
Special projects in some phase of civil engineering. Graduate Staff

FOR GRADUATES ONLY

- CE 601 TRANSPORTATION PLANNING 3(3-0) S
Prerequisite: CE 515
The planning, administration, economics and financing of various transportation engineering facilities. Mr. Cribbins
- CE 602 ADVANCED TRANSPORTATION DESIGN 3(2-3) F
Prerequisite: CE 516
Design of major traffic and transportation engineering projects. Mr. Heimbach
- CE 603 AIRPORT PLANNING AND DESIGN 3(2-3) F
Corequisite: CE 515
The analysis, planning and design of air transportation facilities. Messrs. Heimbach, Horn
- CE 604 URBAN TRANSPORTATION PLANNING 3(3-0) S
Prerequisite: CE 515
Planning and design of urban transportation systems as related to comprehensive urban planning; principles of land use planning, urban thoroughfare planning and regional planning. Messrs. Heimbach, Horn
- CE 623 THEORY AND DESIGN OF ARCHES 3(3-0) F
Prerequisites: CE 422, CE 526
Elastic theory of single- and multi-span arches with various boundary conditions
Development of design criteria for steel and concrete arches. Mr. Uyanik
- CE 624 ANALYSIS AND DESIGN OF STRUCTURAL SHELLS AND FOLDED PLATES 3(3-0) S
Prerequisites: CE 525, EM 511 or consent of instructor
Treatment of roof structures in the form of folded and curved surfaces. Membrane and bending stress analysis of folded plates, shells of revolution, cylindrical and conical shells and free-form systems. Numerical and closed-form solutions. Design criteria for concrete and metallic structures. Messrs. Dean, Uyanik
- CE 625, 626 ADVANCED STRUCTURAL DESIGN I, II 3(2-3) FS
Prerequisite: CE 422
Corequisites: CE 525, CE 526
Complete structural designs of a variety of projects including comparative study of alternative structural systems, synthesis and optimization. Mr. Uyanik
- CE 627 DESIGN OF STRUCTURES FOR DYNAMIC LOADS 3(3-0) S
Prerequisites: CE 526, EM 555
The study of response of structures and structural elements subjected to dynamic loadings such as wind, earthquake and blast. Critical examination of design criteria for earthquake and blast-resistant structures. Mr. Dean

CE 631 FIELD ANALYSIS OF STRUCTURAL SYSTEMS 3(3-0) F

Prerequisite: CE 525 or consent of instructor

Primarily an exposition of the techniques of discrete field mechanics for the analysis of structures. Emphasis is on the closed-form analysis of regular structural lattices or nets and ribbed or reinforced continuous systems. Additional topics include: a cursory study of special continuous field solutions; and open-form solutions for irregular systems.

Mr. Dean

CE 635 ADVANCED THEORY OF CONCRETE STRUCTURES 3(3-0) S

Prerequisite: CE 536 or consent of instructor

Inelastic theory of structural concrete members under flexure, axial load, combined flexure and axial compression, shear and torsion. Yield line theory of slabs. Limit analysis of beams and frames of reinforced and prestressed concrete. Behavior and strength of structural concrete members under dynamic loading.

Mr. Zia

CE 641, 642 ADVANCED SOIL MECHANICS 3(3-0) FS

Prerequisite: Graduate standing

Theories of soil mechanics; failure conditions; mechanical interaction between solids and water, and problems in elasticity and plasticity pertaining to earth-work engineering.

Mr. Wahls

CE 643 HYDRAULICS OF GROUND WATER 3(3-0) FS

Prerequisite: Graduate standing

Principles of ground water hydraulics; theory of flow through idealized porous media; the flow net solution; seepage and well problems.

Mr. Kashef

CE 646 DYNAMICS OF SOILS AND FOUNDATIONS 3(3-0) F

Prerequisite: CE 641

The application of vibration and wave propagation theories to soil media, the review of existing experimental data and empirical procedures for analysis of foundation vibrations, the prediction of soil responses to impulse loads, dynamic properties of soils and methods for their determination, design procedures for foundations subjected to dynamic forces.

Mr. Wahls

CE 671 ADVANCED WATER SUPPLY AND WASTE WATER DISPOSAL 4(3-3) F

Prerequisite: CE 484

Problems relating to water supply and waste collection.

Mr. Smallwood

CE 672 ADVANCED WATER AND WASTES TREATMENT 4(3-3) S

Prerequisite: CE 484

Problems relating to the treatment of water and wastes.

Mr. Smallwood

CE 673 INDUSTRIAL WATER SUPPLY AND WASTE DISPOSAL 3(3-0) FS

Corequisite: CE 571

Water requirements of industry and the disposal of industrial wastes.

Mr. Galler

CE 674 STREAM SANITATION 3(3-0) FS

Corequisite: CE 571

Biological, chemical and hydrological factors that affect stream sanitation and stream use.

Messrs. Galler, Smallwood

CE 698 SPECIAL TOPICS IN CIVIL ENGINEERING

1-3 FS

Prerequisites: Graduate standing, consent of instructor

The study of special advanced topics of particular interest in various areas of civil engineering. Graduate Staff

CE 699 CIVIL ENGINEERING RESEARCH

Credits Arranged FS

Independent investigation of an advanced civil engineering problem; a report of such an investigation is required as a graduate thesis. Graduate Staff

CROP SCIENCE

GRADUATE FACULTY

Professor PAUL H. HARVEY, *Head*

Professors: CHARLES A. BRIM, DOUGLAS S. CHAMBLEE, DONALD A. EMERY, DAN U. GERSTEL, WALTON C. GREGORY, HARRY D. GROSS, GUY L. JONES, KENNETH R. KELLER, ROY L. LOVVORN, THURSTON J. MANN, PHILIP A. MILLER, ROBERT P. MOORE, DONALD E. MORELAND, LYLE L. PHILLIPS, DONALD L. THOMPSON, DAVID H. TIMOTHY, JOSEPH A. WEYBREW; *Professor Emeritus:* GORDON K. MIDDLETON; *Associate Professors:* CARL T. BLAKE, WILLIAM K. COLLINS, WILL A. COPE, WILLIAM B. GILBERT, GEORGE R. GWYNN, JOSHUA A. LEE, WILLIAM M. LEWIS, CHARLES F. MURPHY, JEROME B. WEBER, ARCH D. WORSHAM; *Assistant Professors:* JOSEPH C. BURNS, THADDEUS H. BUSBICE, FREDERICK T. CORBIN, WILLIAM T. FIKE, KENNETH E. FRY, HOWARD G. SMALL, EARL A. WERNSMAN

The Department of Crop Science offers instruction leading to the Master of Science and Doctor of Philosophy degrees in the fields of plant breeding, crop production, forage crops ecology, weed control and plant chemistry. For students who wish general training, the Master of Agriculture degree is offered.

Excellent facilities for graduate training are available. Each student is assigned office and laboratory space. Many special facilities such as preparation rooms for plant and soil samples, cold storage facilities for plant material, air-conditioned rooms for studying the physical properties of cotton fiber and tobacco leaf, and soil and plant analytical service laboratories are available. Greenhouse space and growth control chambers are provided for projects which require these facilities. Sixteen farms are owned and operated by the state for research investigations. These farms are located throughout North Carolina, and include a wide variety of soil and climatic conditions needed for experiments in plant breeding, crop management, forage ecology and weed control.

Strong supporting departments greatly increase opportunities for broad and thorough training. Included among those departments in which graduate students in crop science work cooperatively or obtain instruction are botany, chemistry, entomology, genetics, horticultural science, mathematics, plant pathology, soil science and statistics.

In North Carolina, a state which derives 80 percent of its agricultural income from farm crops, the opportunities for the well-trained agronomist

are exceedingly great. Recipients of advanced degrees in crop science at North Carolina State are found in positions of leadership in research and education throughout the nation and the world.

FOR ADVANCED UNDERGRADUATES

CS 413 PLANT BREEDING 3(3-0) S
Prerequisite: GN 411

An appreciation course in plant breeding. Discussion topics include reproductive systems of higher plants; the evolution and utilization of natural and induced genetic variability; the development of appropriate selection and breeding methods; and the distribution and maintenance of improved varieties.

CS 414 WEEDS AND THEIR CONTROL 3(2-2) F
Prerequisite: CH 220 or equivalent

Principles involved in cultural and chemical weed control. Discussions on chemistry of herbicides and the effects of the chemicals on the plant. Identification of common weeds and their seeds is given.
Mr. Worsham

FOR GRADUATES AND ADVANCED UNDERGRADUATES

CS 511 TOBACCO TECHNOLOGY 2(2-0) S
Prerequisites: CS 311, BO 421 or equivalent

A study of special problems concerned with the tobacco crop. The latest research problems and findings dealing with this important cash crop will be discussed.
Mr. Collins

CS 512 GRASSLAND DYNAMICS 2(2-0) S
Prerequisites: BO 421, ZO 421 or equivalent

A discussion of forage production practices of national and international importance. An attempt will be made to relate the seemingly divergent practices to fundamentals of physiology and ecology. The dynamic relationship among soil, plant, animal and man, as it affects production practices and research, will be emphasized. (Offered by arrangement.)
Graduate Staff

CS 541 (GN 541, HS 541) PLANT BREEDING METHODS 3(3-0) F
Prerequisites: GN 506, ST 511 recommended

An advanced study of methods of plant breeding as related to principles and concepts of inheritance.
Messrs. Haynes, Timothy

CS 542 (GN 542, HS 542) PLANT BREEDING FIELD PROCEDURES 2(0-4) Sum.
Prerequisite: CS 541 (GN 541, HS 541)

Laboratory and field study of the application of the various plant breeding techniques and methods used in the improvement of economic plants.
Mr. Harvey

CS 545 (GN 545) ORIGIN AND EVOLUTION OF CULTIVATED PLANTS 2(2-0) S
Prerequisite: CS 541 or GN 540

Discussion topics include: mankind as a potential cultivator; man's anatomy, physiology and alimentary needs; origins of cultivation; spread of agriculture in terms of various theories; interactions of crops and environments with reference to crop evolution; special attributes of cultigens; modern aspects of evolution (breeding). (Offered in 1968 and alternate years.)
Mr. Lee

CS 550 THE CHEMISTRY OF TOBACCO AND SMOKE

2(2-0) S

Prerequisites: BO 421, CH 220 or equivalent

The course emphasizes the composition of smoke, the combustion process and factors modifying the composition of smoke; the composition of tobacco and factors affecting the composition of tobaccos during growth, curing and ageing.

Mr. Weybrew

CS 591 SPECIAL PROBLEMS

Credits Arranged

Prerequisite: Consent of instructor

Special problems in various phases of crop science. Problems may be selected or will be assigned. Emphasis will be placed on review of recent and current research.

Graduate Staff

FOR GRADUATES ONLY***CS 611 FORAGE CROP ECOLOGY**

2(2-0) S

Prerequisite: BO 442

A study of the effect of environmental factors on the growth of forage crops. Attention will be given to methods of research in forage ecology.

Mr. Chamblee

CS 612 SPECIAL TOPICS IN WEED CONTROL

2(2-0) S

Prerequisites or corequisites: BO 588, CH 223, CS 414

Detailed examination of current concepts and literature of weed control. The chemistry, physiology, ecology, taxonomy, microbiology, equipment and techniques used in weed control research will be discussed.

Messrs. Corbin, Weber

CS 613 (GN 613, HS 613) PLANT BREEDING THEORY

3(3-0) S

Prerequisites: CS 541 or equivalent, GN 513, ST 512 (A course in quantitative genetics is recommended.)

A study of theoretical bases for plant breeding procedures with special emphasis on the relationship between type and source of genetic variability, mode of reproduction and effectiveness of different selection procedures. The latest experimental approaches to plant breeding will be discussed as well as standard procedures.

Messrs. Miller, Wernsman

CS 690 SEMINAR

1(1-0) FS

Prerequisite: Graduate standing

A maximum of two credits is allowed toward the master's degree, however, additional credits toward the doctorate are allowed.

Scientific articles, progress reports in research and special problems of interest to agronomists are reviewed and discussed.

Graduate Staff

CS 699 RESEARCH

Credits Arranged

Prerequisite: Graduate standing

A maximum of six credits is allowed towards the master's degree, but no restrictions toward the doctorate.

Graduate Staff

ECONOMICS**GRADUATE FACULTY***Professor WILLIAM D. TOUSSAINT, Head**Professors: CHARLES E. BISHOP, GEORGE L. CAPEL, ARTHUR J. COUTU, WIL-*

* Students are expected to consult the instructor before registration.

LIAM R. HENRY, H. BROOKS JAMES, PAUL R. JOHNSON, RICHARD A. KING, JAMES G. MADDOX, BERNARD M. OLSEN, WALTER H. PIERCE, CHARLES R. PUGH, ERNST W. SWANSON, THOMAS D. WALLACE, JAMES C. WILLIAMSON, JR.; *Associate Professors*: ROBERT C. BROOKS, WILLIAM M. CROSS-WHITE, MAGDI M. EL-KAMMASH, LEIGH H. HAMMOND, CLEON W. HARRELL, DALE M. HOOVER, LOREN A. IHNEN, EDGAR W. JONES, GENE A. MATHIA, THOMAS E. NICHOLS, JR., ERNEST C. PASOUR, JR., RALPH J. PEELER, JR., *Coordinator of Master's Programs*, JAMES A. SEAGRAVES, RICHARD L. SIMMONS, CARL B. TURNER; *Adjunct Associate Professor*: A. MOAZZUMUL HUQ; *Assistant Professors*: DAVID S. BALL, JOE S. CHAPPELL, ROBERT M. FEARN, CHRISTOPHER GREEN, CHARLES Y. LIU, FRED A. MANGUM, RONALD A. SCHRIMPER, DONALD A. WEST; *USDA Agricultural Economist*: JOSEPH G. SUTHERLAND

The Department of Economics offers programs of study leading to the Master of Economics, the Master of Arts in economics, the Master of Science in agricultural economics and the Doctor of Philosophy degrees. The curriculum includes courses in economic theory, history of economic thought and fields of specialization, including econometrics, marketing, agricultural economics, international trade, economic development and business management analysis. Special attention is given in the curriculum to the development of quantitative analysis skills in economics and to an understanding of economic factors and public policies as they affect regional, national and international development.

Collateral fields of study include statistics, history, politics, sociology, psychology, education and other related fields.

The increasing emphasis being placed on economic growth and development in the South, the nation and throughout the world has resulted in an increased demand for well-trained workers in economics. Graduates of the department with a Master of Economics or a Master of Science degree have opportunities to work in industry, for federal and state agencies and to teach, particularly in the rapidly expanding community college or junior college systems.

Doctor of Philosophy graduates have opportunities for employment as teachers and research workers in universities throughout the nation. Many also find excellent opportunities in various agencies of federal and state government where they are involved in research and educational work. International development agencies employ some graduates, and others find employment as research workers with commercial firms.

The department is located on the first floor of Harrelson Hall and the second floor of Patterson Hall. Graduate students on assistantships or fellowships are provided with office space and equipment, and other graduate students are provided office space when it is available. The department has a modern and well-equipped departmental library, including all the major professional journals. Research reports from federal and state governmental agencies and from universities throughout the United States also are kept on file.

Computational facilities are ideal for students whose research problems involve extensive analysis of data, as well as for those students who want to learn to do their own programming. The department has a well-trained

clerical staff and has one-half interest in an IBM 1620 computer which is available to students. The full computer resources of the new tri-university center at the Research Triangle are available. The basic facility is an IBM 360, Model 75 system, with input-output terminals on each campus including North Carolina State University.

FOR ADVANCED UNDERGRADUATES

EC 402 FINANCIAL INSTITUTIONS 3(3-0) FS
Prerequisite: EC 302

An examination of the flow-of-funds among the principal financial institutions in the American economy; the behavior of the money and capital markets; and the allocation of savings flows into investment expenditures. Mr. Ufen

EC 407 BUSINESS LAW I 3(3-0) FS
Prerequisite: EC 205, EC 206 or EC 212

A course dealing with elementary legal concepts, contracts, agency, negotiable instruments, sales of personal property and insurance. Uniform commercial code considered under all titles applicable. Staff

EC 408 BUSINESS LAW II 3(3-0) FS
Prerequisite: EC 407

Deals with real property, bailments, partnerships, corporations, chattel mortgages, mortgages on real estate, landlord and tenant, insurance, wills, suretyship, conditional sales and bankruptcy. Uniform commercial code considered under all titles applicable. Mr. Dixon

EC 409 INTRODUCTION TO PRODUCTION COST 3(3-0) FS
Prerequisite: EC 312

An introduction to accounting for manufacturing, fabrication and construction-type enterprises. The determination and allocation of costs of materials, labor and overhead. Special emphasis is placed on managerial analysis, interpretation and control of cost data. Mr. Fails

EC 410 PUBLIC FINANCE AND FISCAL POLICY 3(3-0) F
Prerequisites: EC 205, EC 206 and EC 301 recommended

An analysis of the economic effects of government taxation and expenditure decisions. Major attention will be given to current tax policy issues both at the federal level and at the state-local level. A description of different types of budgets and the effect of budgetary policy upon the level of economic activity will also be included. Mr. Green

EC 411 MARKETING METHODS 3(3-0) FS
Prerequisite: EC 205, EC 206 or EC 212

Marketing institutions and their functions and agencies; retailing, market analysis; problems in marketing. Mr. Dornburg

EC 413 COMPETITION, MONOPOLY AND PUBLIC POLICY 3(3-0) FS
Prerequisite: EC 301 recommended but not required

An analysis of the effect of modern industrial structure on competitive behavior and performance, in the light of contemporary price theory and the theory of workable competition. A critical evaluation of the legislative content, judicial interpretation and economic effects of the antitrust laws. Mr. West

EC 414 TAX ACCOUNTING 3(2-1) F
 Prerequisite: EC 312

An analysis of the federal tax laws relating to the individual and business. Determining and reporting income. Payroll taxes and methods of reporting them. Actual practice in the preparation of income tax returns. Mr. Sandman

EC 415 FARM APPRAISAL AND FINANCE 3(2-3) F
 Prerequisite: EC 303

Examination of the source of the productivity and value of farm inputs; a critical analysis of and practice in the use of farm appraisal procedures currently used for land and buildings; review of the sources of and repayment practices used in short and intermediate credit in agriculture; consideration of the forces operating in the whole economy with an examination of the implications of these changes for both the lender and borrower in agriculture.

Mr. Neuman

EC 420 CORPORATION FINANCE 3(3-0) FS
 Prerequisites: EC 205, EC 312

Financial instruments and capital structure; procuring funds, managing working capital; managing corporate capitalization; financial institutions and their work. Mr. Ufen

EC 425 INDUSTRIAL MANAGEMENT 3(3-0) FS
 Prerequisite: Junior standing

Principles and techniques of modern scientific management relation of finance, marketing, industrial relations, accounting and statistics to production planning and control; analysis of economic, political and social influences on production. Mr. Wood

EC 426 PERSONNEL MANAGEMENT 3(3-0) FS
 Prerequisite: Junior standing

The scientific management of manpower, from the viewpoint of the supervisor and the personnel specialists. A study of personnel policy and a review of the scientific techniques regarding the specific problems of employment, training, promotion, transfer, health and safety, employee service and joint relations.

Mr. Wood

EC 430 AGRICULTURAL PRICE ANALYSIS 3(3-0) F
 Prerequisite: EC 311

Principles of price formation; the role of price in the determination of economic activity; the interaction of cash and future prices for agricultural commodities; methods of price analysis, construction of index numbers, analysis of time series data including the estimation of trend and seasonal variations in prices. Mr. Schrimper

EC 431 LABOR ECONOMICS 3(3-0) FS
 Prerequisite: EC 301 recommended but not required

An economic approach to the labor market and to labor market problems including unemployment and the determination of wages, hours and working conditions under various labor market structures. An examination of the economic effects of trade unions and an introduction to the theory of human capital. Messrs. Fearn, Hausman

EC 432 INDUSTRIAL RELATIONS

3(3-0) FS

Prerequisite: EC 205 or EC 212

Collective bargaining. Analysis of basic labor law and its interpretation by the courts and governmental agencies. An examination of specific terms of labor contracts and their implications for labor and management. An examination of labor objectives and tactics and management objectives and tactics. Problems of operating under the labor contract.

Mr. Bartley

EC 440 ECONOMIC DEVELOPMENT

3(3-0) S

Prerequisite: EC 302

An examination of the institutional background required for national economic development. The conditions apparent for past growth of nations are compared with conditions obtained in presently retarded nations. Conclusions are drawn from this comparison to provide an introduction to the theoretical models of growth.

Mr. Maddox

EC 441 AGRICULTURAL DEVELOPMENT IN FOREIGN COUNTRIES

3(3-0) S

Prerequisite: EC 205 or EC 206 or EC 212

Identification of agricultural problems in underdeveloped countries; a review of economic criteria for analyzing the problems of developing agriculture and the techniques of analysis for solving such problems. Case studies of development programs in various countries will be discussed.

Mr. Coutu

EC 442 EVOLUTION OF ECONOMIC IDEAS

3(3-0) S

Prerequisite: EC 301

An analysis of the development of economic thought and method during the past two centuries. Economics as a cumulative body of knowledge in a context of emerging technology, changing institutions, pressing new problems and the growth of science.

Mr. Turner

EC 446 ECONOMIC FORECASTING

3(3-0) S

Prerequisite: EC 302 and EC 317 recommended but not required

An examination of the basic principles and techniques of economics forecasting with strong emphasis upon the economic models upon which forecasting is based.

Staff

EC 448 INTERNATIONAL ECONOMICS

3(3-0) F

Prerequisites: EC 205 and EC 206 or EC 212

A study of international economics, including trade, investment, monetary relations and certain aspects of economic development. Emphasis upon analytical and policy approaches, although some institutional material is included.

Mr. Ball

EC 451 INTRODUCTION TO ECONOMETRICS

3(3-0) FS

Prerequisites: EC 301, EC 302 and EC 317 or ST 311

An introduction to the measurement, specification, estimation and interpretation of functional relationships through single equation least-squares techniques. Simple and multiple regression, curvilinear regression and various transformations will be used to measure: demand, cost, production, consumption and investment relationships.

Mr. El-Kammash

EC 470 (HI 470) EVOLUTION OF THE AMERICAN ECONOMY

3(3-0) S

Prerequisites: EC 206 and HI 112 or HI 348 or HI 412

The continuing advances of modern industrialization are related to the development of the American nation. Contemporary problems and issues are analyzed with reference to their origins in the historical growth of the economy.

Mr. Olsen

EC 475 COMPARATIVE ECONOMIC SYSTEMS 3(3-0) F
Prerequisite: EC 205 or EC 206

A general study of different economic systems. Concentration will be given to capitalist or market economies and these will be contrasted with collectivist types of systems. Emphasis will be given to the Soviet economy. Mr. Turner

EC 487 (TX 487) SALES MANAGEMENT FOR TEXTILES 3(3-0) S
(See Textile Technology, page 249.)

EC 490, 491 SENIOR SEMINARS IN ECONOMICS 3(3-0) FS
Prerequisites: EC 301, EC 302

The terminal courses in undergraduate study of economics. The student is assisted in summarizing his training, and in improving his capacity to recognize problems and to select logically consistent means of solving problems. This is done on a small-group and individual basis. Staff

FOR GRADUATES AND ADVANCED UNDERGRADUATES

EC 501 PRICE THEORY 3(3-0) FS
Prerequisite: EC 301

An intensive analysis of the determination of prices and of market behavior, including demand, cost and production, pricing under competitive conditions and pricing under monopoly and other imperfectly competitive conditions.

Mr. Pasour

EC 502 INCOME AND EMPLOYMENT THEORY 3(3-0) FS
Prerequisite: EC 302

A study of the methods and concepts of national income analysis with particular reference to the role of fiscal and monetary policy in maintaining full employment without inflation.

Graduate Staff

EC 510 (PS 510) PUBLIC FINANCE 3(3-0) FS
Prerequisite: EC 205

A survey of the theories and practices of governmental taxing, spending and borrowing, including intergovernmental relationships and administrative practices and problems.

Mr. Block, Graduate Staff

EC 512 AGRICULTURAL FACTOR MARKETS 3(3-0) S
Prerequisite: EC 301

This course is oriented to the relative significance of land, labor and capital as factors of production in a modern agricultural economy, including major changes in the respective roles of these factors of production in recent years. The structure and efficiency of markets for these factors, including relevance of the institutional and attitudinal setting in each type of market and nature of the demand-supply equilibration, will be investigated. Public policies will also be reviewed.

Graduate Staff

EC 521 MARKETS AND TRADE 3(3-0) F
Prerequisite: EC 301

A study of marketing firms as producers of marketing services and their role in the pricing process; the influence of government policies on the behavior of marketing firms; methods for increasing the efficiency of marketing agricultural products.

Mr. King

EC 523 PLANNING FARM AND AREA ADJUSTMENTS

3(2-2) S

Prerequisite: EC 303

The application of economic principles in the solution of production problems on typical farms in the state; methods and techniques of economic analysis of the farm business; application of research findings to production decisions; development of area agricultural programs.

Graduate Staff

EC 525 MANAGEMENT POLICY AND DECISION MAKING

3(3-0) FS

Prerequisite: EC 301

A review and consideration of modern management processes used in making top-level policies and decisions. An evaluation of economic, social and institutional pressures, and of the economic and noneconomic motivations, which impinge upon the individual and the organization. The problem of coordinating the objectives and the mechanics of management is examined.

Graduate Staff

EC 531 MANAGEMENT OF INDUSTRIAL RELATIONS

3(3-0) S

Prerequisite: EC 301

A seminar course designed to round out the technical student's program. Includes a survey of the labor movement organization and structure of unions, labor law and public policy, the union contract and bargaining process, and current trends and tendencies of the field of collective bargaining.

Mr. Fearn

EC 533 AGRICULTURAL POLICY

3(3-0) S

Prerequisite: EC 301

A review of the agricultural policy and action programs of the federal government as regards both input supply and commodities, analysis of objectives, principal means and observable results as regards resource use and income distribution within agriculture, and between agriculture and the rest of the economy; appraisal of the effects alternative policy proposals would have on domestic and foreign consumption.

Mr. Hoover

EC 550 MATHEMATICAL MODELS IN ECONOMICS

3(3-0) S

Prerequisites: EC 301, EC 302, MA 212 and MA 405 recommended but not required

An introductory study of economic models emphasizing their formal properties. The theory of individual economic units is presented as a special case in the theory of inductive behavior. Mathematical discussions of the theory of the consumer, the theory of the firm and welfare economics will show the relevance of such topics as constrained maxima and minima, set theory, partially and simply ordered systems, probability theory and game theory to economics.

Mr. Harrell

EC 551 AGRICULTURAL PRODUCTION ECONOMICS

3(3-0) F

Prerequisite: EC 301

An economic analysis of agricultural production including: production functions, cost functions, programming and decision-making principles; and the applications of these principles to farm and regional resources allocation, and to the distribution of income to and within agriculture.

Graduate Staff

EC 555 LINEAR PROGRAMMING

3(3-0) FS

Prerequisites: EC 301, MA 212, MA 405

Recent developments in the theory of production, allocation and organization. Optimal combination of integrated productive processes within the firm. Applications in the economics of industry and of agriculture.

Mr. Harrell

EC 561 (ST 561) INTERMEDIATE ECONOMETRICS 3(3-0) S
Prerequisite: EC 501, ST 501 or MA 112

The formalization of economic hypotheses into testable relationships and the application of appropriate statistical techniques will be emphasized. Major attention will be given to procedures applicable for single equation stochastic models expressing micro- and macro-economic relationships. Statistical considerations that are relevant in working with time series and cross sectional data in economic investigations will be covered. The use of simultaneous equation models and the available estimation techniques will be surveyed. Mr. Schrimper

EC 585 (TX 585) MARKET RESEARCH IN TEXTILES 3(3-0) S
(See Textile Technology, page 250.)

EC 590 SPECIAL ECONOMICS TOPICS Maximum 6
Prerequisite: Consent of instructor

An examination of current problems in economics organized on a lecture-discussion basis. The content of the course will vary as changing conditions require the use of new approaches to deal with emerging problems. Graduate Staff

EC 598 TOPICAL PROBLEMS IN ECONOMICS Maximum 6
Prerequisite: Consent of instructor

An investigation of topics of particular interest to advanced students under the direction of faculty members on a tutorial basis. Credits and content will vary with the needs of the students. Graduate Staff

FOR GRADUATES ONLY

EC 600 ADVANCED PRICE THEORY 3(3-0) FS
Prerequisites: EC 501, MA 212

Alternative economic organizations and the role of prices; equilibrium and price determination in a market economy; theory of consumer behavior; derivation of individual demand curves and aggregation to market supply curves; demand for factors of production. Mr. Ihnen

EC 601 PRICES, VALUE AND WELFARE 3(3-0) FS
Prerequisite: EC 600

The supply of factors of production; alternative nonmonetary theories of capital and interest; productivity; income distribution; determinants of firm size; the nature of market organization; welfare economics topics, including externalities, compensation, social welfare function and consumer surplus. Mr. Hoover

EC 602 ADVANCED INCOME AND EMPLOYMENT THEORY 3(3-0) FS
Prerequisite: EC 502

The course consists of an analysis of the forces determining the level of income and employment; a review of some of the theories of economic fluctuations; and a critical examination of a selected macro-economic system. Graduate Staff

EC 603 HISTORY OF ECONOMIC THOUGHT 3(3-0) FS
Prerequisites: EC 501 and EC 502 or equivalent

A systematic analysis of the development and cumulation of economic thought, designed in part to provide a sharper focus and more adequate perspective for the understanding of contemporary economics. Mr. Turner

EC 604 MONETARY ECONOMICS**3(3-0) F****Prerequisite:** EC 602

Consideration of the money market and portfolio management, the cost of capital, effects of monetary phenomena on investment and accumulation of wealth with emphasis throughout on problems arising from uncertainty; general equilibrium theory of money, interest, prices and output.

Graduate Staff**EC 610 THEORY OF PUBLIC FINANCE****3(3-0) FS****Prerequisites:** EC 501, EC 502

An application of micro-economic and macro-economic theory to the budgetary policies of the governmental sector with emphasis on the welfare effects of taxation and expenditure policies and the impact on optimum allocation and distribution of resources.

Mr. Green**EC 631 HUMAN CAPITAL****3(3-0) F****Prerequisites:** EC 501, EC 502

An examination of human resource development from an economic view. Emphasis is placed on recent research and theoretical developments related to the economics of education, on-the-job training, discrimination and migration.

Mr. Ihnen**EC 632 ECONOMIC WELFARE AND PUBLIC POLICY****3(3-0) S****Prerequisite:** EC 601

Description of the conditions defining optimal resource allocation; application of the conditions for maximum welfare in appraisal of economic policies and programs affecting resource allocation and income distribution.

Mr. Hoover**EC 640 ANALYSIS OF ECONOMIC DEVELOPMENT****3(3-0) S****Prerequisite:** EC 502

Theoretical and empirical studies of the processes of economic development are compared and analyzed. Contemporary developments in the theories of economic growth are related to the problems of underdeveloped countries. Policies and programs needed for effecting economic development are studied and evaluated for consistency.

Mr. Olsen**EC 641 AGRICULTURAL PRODUCTION AND SUPPLY****3(3-0) S****Prerequisites:** EC 601, ST 513

An advanced study in the logic of, and empirical inquiry into, producer behavior and choice among combinations of factors and kinds and quantities of output; aggregative consequences of individuals' and firms' decisions in terms of product supply and factor demand; factor markets and income distribution; general interdependency among economic variables.

Mr. Seagraves**EC 642 CONSUMPTION, DEMAND AND MARKET INTERDEPENDENCY****3(3-0) F****Prerequisites:** EC 601, ST 513

An analysis of the behavior of individual households and of consumers in the aggregate with respect to consumption of agricultural products; the impact of these decisions on demand for agricultural resources; the competition among agricultural regions and for markets; and the interdependence between agriculture and other sectors of the economy.

Mr. King**EC 645 PLANNING PROGRAMS FOR ECONOMIC DEVELOPMENT****3(3-0) FS****Prerequisites:** EC 550, EC 640

Consideration is given to the necessary quantitative measures for basing plans

of national economic development. Models for program development and the techniques for their construction are studied. Mr. Olsen

EC 648 THEORY OF INTERNATIONAL TRADE 3(3-0) S
Prerequisites: EC 501, EC 502

A consideration of the specialized body of economic theory dealing with the international movement of goods, services, capital and payments. Also, a theoretically oriented consideration of policy. Messrs. Ball, Johnson

EC 650 ECONOMIC DECISION THEORY 3(3-0) FS
Prerequisite: EC 501 or equivalent, EC 550 or EC 555

Study of general theories of choice. Structure of decision problems, the role of information; formulation of objectives. Current research problems. Mr. Harrell

EC 651 (ST 651) ECONOMETRICS 3(3-0) F
Prerequisites: EC 600, ST 421, ST 502

The role and uses of statistical inference in economic research; the problem of spanning the gap from an economic model to its statistical counterpart; measurement problems and their solutions arising from the statistical model and the nature of the data; limitations and interpretation of results of economic measurement from statistical techniques. Mr. Wallace

EC 652 (ST 652) TOPICS IN ECONOMETRICS 3(3-0) S
Prerequisite: EC 651 (ST 651)

Survey of current literature on estimation and inference in simultaneous stochastic equations systems. Techniques for combining cross section and time series data including covariance, error correlated and error component models. Lag models and inference in dynamic systems. Production functions, productivity measurement and hypotheses about economic growth. Complete and incomplete prior information in regression analysis. Nonlinear estimation in economic models. Mr. Wallace

EC 665 ECONOMIC BEHAVIOR OF THE ORGANIZATION 3(3-0) FS
Prerequisite: EC 501

This seminar will apply methods and findings derived from the behavioral sciences to the economic behavior of the organization, particularly the business firm. Among the approaches which may be utilized are organization theory, information theory, reference group theory and decision theory.

Messrs. Henry, Swanson

EC 699 RESEARCH IN ECONOMICS Credits Arranged
Prerequisite: Graduate standing

Individual research in economics under staff supervision and direction.

Graduate Staff

SCHOOL OF EDUCATION

JAMES BRYANT KIRKLAND, *Dean*

The School of Education offers graduate programs leading to the master's degree for students majoring in adult education, agricultural education, industrial arts education, vocational industrial education, guidance and personnel services, mathematics education, psychology and science education.

Graduate students in education may pursue programs leading to the degrees of Master of Science or Master of Education.

The Master of Science degree is regarded as a research degree and as preparation for further graduate study. Programs leading to the Master of Science degree are planned to include a major (20 semester hours) in some specialized area of education and a minor (10 or more semester hours) in some other field such as psychology or agricultural economics. If two minors are chosen, a minimum of six semester hours will be required in each.

The Master of Education degree is designed to meet the needs of students preparing to teach in the secondary schools and community colleges and to assume leadership positions in adult education programs. The program of study for the professional degree allows a wider latitude in the choice of course work outside the major than is allowed by the Master of Science program.

A problem may be substituted for a thesis if, in the opinion of the student's advisory committee, this alternative contributes maximally to the student's objective. Knowledge of a foreign language is not required for the Master of Education degree.

Graduate programs leading to the Ed.D. degree are offered for majors in adult education and occupational education. The doctoral program is designed to meet the needs of such personnel as teachers, directors, supervisors and teacher educators affiliated with programs of vocational and industrial arts education at the local and state level; administrative officers of technical institutes and community colleges; directors of guidance and personnel services; directors of adult basic education; and cooperative extension personnel. Graduate programs will be planned in terms of educational objectives, experience and preparation of the enrollees. However, each program will include courses in such areas as educational foundations, behavioral sciences and research in addition to the specialty area.

Graduate programs leading to the Ph.D. degree are also offered for majors in psychology. The major objectives of this doctoral program are to prepare professional psychologists for careers in scientific research and professional academicians for an effective role in the university community. Programs will be planned in terms of the educational objectives and preparation of the enrollees. However, all enrollees will pursue the courses comprising the core. Provisions will be made for specialization in any of the narrower disciplines through additional courses and the minor.

The School of Education is located in Tompkins Hall where research and laboratory facilities are provided for graduate study.

A limited number of teaching and research assistantships are available for qualified graduate students. National Defense Education Act loans are also available for graduate students needing financial aid.

FOR GRADUATES AND ADVANCED UNDERGRADUATES

ED 504 PRINCIPLES AND PRACTICES OF INTRODUCTION TO
VOCATIONS

3(3-0) FS

Prerequisites: Twelve hours of education

This course is designed for teachers of Introduction to Vocations. Emphasis will be given to the place of the Introduction to Vocations program in the over-

all school curriculum, special methods of instruction, use of teaching aids and use of student evaluation instruments. An overview will also be presented in the areas of community organization, job markets, group procedures, occupational and educational information and the changing occupational structure in our society.

Mr. Clary

ED 505 PUBLIC AREA SCHOOLS 3(3-0) FS
Prerequisite: Graduate standing

Junior and community colleges, technical institutes, vocational schools and branches of universities: their development, status and prospects; policy and policy-making clientele, purposes, evaluation programs, personnel, organization, administration, financing, facilities, research and development functions.

Graduate Staff

ED 506 EDUCATION OF EXCEPTIONAL CHILDREN 3(2-2) F
Prerequisites: Six hours in education or psychology

Discussion of principles and techniques of teaching the exceptional child with major interest on the mentally handicapped and slow learner. Practice will be given in curriculum instruction for groups of children, individual techniques for dealing with retarded children in the average classroom. Opportunity for individual work with an exceptional child will be provided.

Mr. Corter

ED 507 ANALYSIS OF READING ABILITIES 3(3-0) F
Prerequisites: Six hours in education or psychology

A study of tests and techniques used in determining specific abilities; a study of reading retardation and factors underlying reading difficulties.

Mr. Rust

ED 508 IMPROVEMENT OF READING ABILITIES 3(3-0) S
Prerequisites: Six hours of education or psychology

A study of methods used in developing specific reading skills or in overcoming certain reading difficulties; a study of methods used in developing pupil vocabularies and work analysis skills; a study of how to control vocabulary burden of reading material.

Mr. Rust

ED 509 METHODS AND MATERIALS—TEACHING RETARDED CHILDREN 3(3-0) S Sum.
Prerequisite: ED 506

Emphasis on understanding and correlating developmental levels of mentally retarded children and appropriate educational methods and materials. Use of individual child's diagnostic data; consideration of long and short range educational goals; curriculum planning in terms of realistic usefulness; scheduling; teacher guidance of children toward social and emotional maturity.

Graduate Staff

ED 552 INDUSTRIAL ARTS IN THE ELEMENTARY SCHOOL 3(3-0) Sum.
Prerequisites: Twelve hours in education, consent of instructor

This course is organized to help elementary teachers and principals understand how tools, materials and industrial processes may be used to vitalize and supplement the elementary school child's experiences. Practical children's projects along with the building of classroom equipment.

Graduate Staff

ED 563 EFFECTIVE TEACHING 3(3-0) FS
Prerequisites: Twelve hours in education including student teaching

Analysis of the teaching-learning process; assumptions that underlie course approaches; identifying problems of importance; problem solution for effective

learning; relationship of learning and doing; responsibility for learning; evaluation of teaching and learning; making specific plans for effective teaching.

Graduate Staff

FOR GRADUATES ONLY

ED 602 CURRICULUM

3(3-0) S

Prerequisites: PSY 510, PSY 535, ED 503 and/or comparable course in occupational education

A course designed to equip the student with the conceptual tools and intellectual skills needed to develop and critically assess curricula in all educational fields. The elements of the curriculum development process that are studied in the course include: identification and formulation of educational objectives, selection of learning experiences, developing and implementing plans for evaluating learning experiences and assessing educational outcomes, and staff-leader involvement in the curriculum development process.

Mrs. Quinn

ED 608 SUPERVISION OF VOCATIONAL AND INDUSTRIAL ARTS EDUCATION

3(3-0) F

Prerequisite: ED 527 or ED 554 or ED 609 or ED 630 or equivalent

An intensive study of the principles of supervision and the applications of these principles to the vocational and industrial arts education programs being conducted in secondary, post-secondary and adult facilities. Emphasis is placed upon the competencies needed in supervisors in order to effectively discharge their responsibilities in such areas as teacher selection, teacher transfer and promotion, assistance in teacher professional growth, the conduct of workshops and in-service programs for professional and nonprofessional staff, self-evaluative processes in education, curriculum generation and modification, guidance and counseling provisions and action research.

Messrs. Hanson, Nerden, Graduate Staff

ED 610 ADMINISTRATION OF VOCATIONAL AND INDUSTRIAL ARTS EDUCATION

3(3-0) S

Prerequisite: ED 527 or ED 554 or ED 609 or ED 630 or equivalent

An intensive study of the major elements of administrative practice applied to vocational and industrial arts education, as it is being conducted in comprehensive high schools, comprehensive community colleges, technical institutes and area vocational centers. Emphasis is placed upon leadership, personnel management, instructional program management and evaluation, public relations and financial management, in connection with preparatory, part-time supplementary, extension and adult education programs of vocational and industrial arts education.

Messrs. Hanson, Nerden, Graduate Staff

ED 614 MODERN PRINCIPLES AND PRACTICES IN SECONDARY EDUCATION

2(2-0) FS

Prerequisites: Twelve hours in education

Foundations of modern programs of secondary education purposes, curriculum, organization, administration, and the place and importance of the high school in the community in relation to contemporary social force.

Graduate Staff

ED 615 INTRODUCTION TO EDUCATIONAL RESEARCH

3(3-0) FS

Prerequisite: PSY 535 or equivalent

An introductory course for students preparing for an advanced degree. The purposes are: to assist the student in understanding the meaning and purpose

of educational research and the research approach to problems; to develop the student's ability to identify educational problems, and to plan and carry out research to solve these problems; to aid in the preparation of the research report. Special attention is given to tools and methods of research. Consideration is also given to the educator as a consumer of research. Graduate Staff

ED 665 SUPERVISING STUDENT TEACHING

3(3-0) FS

Prerequisites: Twelve hours in education

A study of the program of student teaching in teacher education. Special consideration will be given to the role of the supervising teacher including the following areas: planning for effective student teaching, observation and orientation, school community study, analysis of situation, evaluating student teachers and coordination with North Carolina State University. Graduate Staff

ED 699 RESEARCH

Credits Arranged

Prerequisites: Fifteen hours, consent of advisor

Individual research on a specific problem of concern to the student.

Graduate Staff

NOTE: A description of the specialized courses offered by the several departments in the School of Education may be found on the following pages: Adult Education, page 57; Agricultural Education, page 59; Guidance and Personnel Services, page 156; Industrial and Technical Education, page 166; Mathematics and Science Education, page 183; Psychology, page 230.

ELECTRICAL ENGINEERING

GRADUATE FACULTY

Professor GEORGE B. HOADLEY, *Head*

Professors: WILLIAM J. BARCLAY, ARTHUR R. ECKELS, WALTER A. FLOOD, DONALD R. RHODES, JOHN STAUDHAMMER, WILLIAM D. STEVENSON, JR., *Associate Head and Graduate Administrator*, FREDERICK J. TISCHER; *Visiting Professor:* MAKOTO ITOH; *Adjunct Professor:* GERHARD K. MEGLA; *Associate Professors:* NORMAN R. BELL, EDWARD G. MANNING, NEELY F. J. MATTHEWS, WILBUR G. PETERSON; *Adjunct Associate Professor:* ERICH CHRISTIAN; *Assistant Professors:* JOHN R. HAUSER, MICHAEL A. LITTLEJOHN, JOHN B. O'NEAL, JR.; *Adjunct Assistant Professors:* LARRY K. MONTEITH, CHARLES C. TAPPERT

The Department of Electrical Engineering offers the Master of Electrical Engineering, Master of Science and Doctor of Philosophy degrees. Graduate work in electrical engineering at the first-year or master's level is limited to one or two areas of specialization. In the more advanced study for the doctorate a comprehensive understanding of all fields of electrical engineering is required, and specialization appears in the research problem undertaken.

Advanced courses of a general and fundamental nature are required for those who plan to carry their advanced studies to the level of the doctorate. Minor sequences of study in advanced mathematics or physics are planned to fit the needs of individual students.

The laboratories of the department are exceedingly well equipped for research in electromagnetics, electronic circuits, automatic controls and

solid-state materials and devices. Active research is in progress in these and other areas.

FOR ADVANCED UNDERGRADUATES

EE 401 ADVANCED ELECTRIC CIRCUITS 3(2-2) F

Prerequisites: EE 202, MA 301

Transient analysis of electric circuits by the Laplace transform method, the study of transient and sinusoidal steady-state response in terms of poles and zeros of network functions.

EE 403 ELECTRIC NETWORK DESIGN 3(1-2) S

Prerequisite: EE 401

A continuation of EE 401. The study of design methods for such electric networks as resonant systems, filters, feedback stabilizers, audio amplifier compensation and dividing networks.

EE 430 ESSENTIALS OF ELECTRICAL ENGINEERING 4(3-3) F

Prerequisite: EE 202 or EE 332

Not available to undergraduates in electrical engineering.

Essential theory of electric circuits, electron tubes, solid-state devices, transformers and rotating machines as needed to supply the electrical background for instrumentation and control theory. Intended primarily for graduate students who do not have an electrical engineering undergraduate degree.

EE 431 ELECTRONIC ENGINEERING 3(2-3) F

Prerequisite: EE 314

Comprehensive coverage of circuits and equipment using electronic devices; variable frequency effects; amplifiers, oscillators, modulators, detectors, wave-shaping circuits, generators of non-linear waveforms; basic pulse techniques; principles of electronic analog computers. Emphasis on quantitative analysis and engineering design.

EE 432 COMMUNICATION ENGINEERING 3(2-3) S

Prerequisite: EE 431

Application of electronic circuits and equipment to radio and wire communication systems. Elements of complete systems, wave propagation, antennas, transmitters, receivers, television, radar, electronic navigation systems, noise, special applications.

EE 433 ELECTRIC POWER ENGINEERING 3(2-3) F

Prerequisite: EE 305

A study of industrial power supply and power factor correction; direct and alternating current motor characteristics, starting methods, dynamic braking and speed control; motor applications and industrial control apparatus.

EE 434 POWER SYSTEM ANALYSIS 3(2-3) S

Prerequisite: EE 305

Analysis of problems encountered in the long-distance transmission of electric power. Line parameters by the method of geometric mean distances. Circle diagrams, symmetrical components and fault calculations. Elementary concepts of power system stability. Applications of digital computers to power system problems.

EE 435 ELEMENTS OF CONTROL**3(2-3) F****Prerequisites:** EE 314, EE 305 or EE 430

Introductory theory of open- and closed-loop control. Functions and performance requirements of typical control systems and system components. Dynamic analysis of error detectors, amplifiers, motors, demodulators, analog components and switching devices. Component transfer characteristics and block diagram representation.

EE 438 INSTRUMENTATION IN NUCLEAR TECHNOLOGY**3(2-3) S****Prerequisites:** MA 301, EE 430 or EE 314

Radiation detectors, pulse amplifiers, pulse shapers, amplitude discriminators, counters, coincidence circuits.

EE 440 FUNDAMENTALS OF DIGITAL SYSTEMS**3(3-0) F****Prerequisite:** EE 314 or EE 430

The basic theory of digital computation and control. Introduction to number systems, data handling, relay algebra, switching logic, memory circuits, the application of electronic devices to switching circuits and the design of computer control circuits.

EE 442 INTRODUCTION TO SOLID-STATE DEVICES**3(3-0) S****Prerequisites:** MA 301, PY 407

An introduction to the microscopic phenomena responsible for the operation of solid-state electronic devices. A qualitative description of the band model of solids is followed by a description of the transport properties of charge carriers. P-n junction diodes and transistors, solar cells, controlled rectifiers, tunnel diodes and unijunction transistors are treated along with more recently developed devices.

EE 445 INTRODUCTION TO ANTENNAS**3(3-0) F****Prerequisites:** EE 304, EE 314

An introduction to antenna engineering. Consideration will be given to radiation from single-element radiators, radiation patterns, directive properties, aperture concepts, gain and impedances. Multielement antennas and arrays with various amplitude distributions and phasings and thin linear antennas will be treated in some detail. Antennas of current usage such as cylindrical antennas, reflector systems, slots, horns, lenses, traveling wave antennas and frequency-independent structures will be discussed.

EE 448 INTRODUCTION TO MICROWAVES**3(3-0) S****Prerequisites:** EE 304, EE 314

A study of the elementary theory and special techniques required at microwave frequencies. Both passive and active circuits will be considered. Transmission elements, special-purpose components, generators, to include klystrons, magnetrons, traveling wave tubes and amplifiers such as parametric devices and the maser will be discussed. The description of microwave networks by the scattering matrix will be presented.

EE 491 ELECTRICAL ENGINEERING SENIOR SEMINAR**1(0-2) F****Prerequisite:** Senior standing

Weekly meetings for the delivery and discussion of student papers on topics of current interest in electrical engineering.

FOR GRADUATES AND ADVANCED UNDERGRADUATES

EE 503 LINEAR NETWORK THEORY

3(3-0) F

Prerequisites: EE 314, MA 301, B average in EE and MA

Analysis of linear networks, with emphasis on the system functions of the network in the frequency domain and response in the time domain.

Mr. Stevenson

EE 504 INTRODUCTION TO NETWORK SYNTHESIS

3(3-0) S

Prerequisite: EE 503, B average in electrical engineering and mathematics

A development of the methods of network synthesis of one-port and two-port passive structures based on partial fraction techniques.

Mr. Stevenson

EE 506 DYNAMICAL ANALOGIES

3(3-0) S

Prerequisites: EE 202 or EE 331, EM 301, MA 301, B average in EE, EM and MA

A study of dynamic systems in various branches of engineering and science with emphasis on the similarities that exist among such integrated groups of devices. Analogous elements and quantities in these fields as determined from equations basic to each. Analytical formulation of system problems in acoustical, electrical, mechanical and related fields and their solution by analog methods. Use of electronic analog computers for the solution of system problems.

Mr. Eckels

EE 507 ELECTROMAGNETICS

3(3-0) F

Prerequisites: EE 303, EE 314, MA 301, B average in EE and MA

Basic principles of electromagnetic field theory in vector analysis formulation, including static electric and magnetic fields, Maxwell's equations and applications to guided waves.

Mr. Matthews

EE 511 ELECTRONIC CIRCUITS

3(3-0) F

Prerequisites: EE 314 or EE 430, B average in EE and MA

Solid-state and vacuum electronic devices in amplifiers, feedback systems, oscillators, modulators, switching and wave-shaping circuits. Generation of non-linear waveforms; electronic instruments; circuits basic to electronic computers. Use of complex frequency concepts to obtain generalized response. Communication, power and industrial applications. Synthesis of circuits to satisfy system requirements.

Mr. Barclay

EE 512 COMMUNICATION THEORY

3(3-0) F

Prerequisites: EE 431 or EE 511, B average in EE and MA

The frequency and time domain, modulation, random signal theory, autocorrelation, basic information theory, noise, communication systems.

Mr. Barclay

EE 516 FEEDBACK CONTROL SYSTEMS

3(3-0) S

Prerequisites: EE 401, EE 435

Study of feedback systems for automatic control of physical quantities such as voltage, speed and mechanical position. Theory of regulating systems and servo-mechanisms. Steady-state and transient responses. Evaluation of stability. Transfer function loci and root locus plots. Analysis using differential equation and operational methods. System compensation and introduction to design.

Mr. Peterson

EE 517 CONTROL LABORATORY

1(0-3) S

Corequisite: EE 516

Laboratory study of feedback systems for automatic control of physical quantities such as voltage, speed and mechanical position. Characteristics of

regulating systems and servo-mechanisms. The laboratory work is intended to contribute to an understanding of the theory developed in EE 516.

Mr. Peterson

EE 520 FUNDAMENTALS OF LOGIC SYSTEMS 3(3-0) F

Prerequisites: EE 314 or EE 430, B average in EE and MA

A study of switching algebra, logic circuitry, systematic minimization, block diagrams, logic systems in computers, diode and transistor logic, symmetric functions, iterative networks, cascaded systems, sequential circuits and pulsed operation.

Mr. Bell

EE 521 DIGITAL COMPUTER TECHNOLOGY AND DESIGN 3(3-0) S

Prerequisite: EE 520

A study of the internal organization and structure of digital systems including toggle circuits, gates and pulse circuitry. Analysis and synthesis of the major components of computers, including the logic section, counters, registers, storage devices, input-output and control.

Mr. Bell

EE 531, 532 INTRODUCTION TO SOLID-STATE MATERIAL SCIENCE 3(3-0) FS

Prerequisites: MA 301, PY 407

Corequisite: MAE 301

Elementary quantum mechanics, statistical mechanics and Boltzmann transport theory are first presented as basic tools. The study of direct and reciprocal Bravais lattices and of distributions of modes of lattice vibrations establishes the environment of electrons whose behavior in crystalline solids is then developed by presentations of free electron theory and the band theory. Behavior of electrons and holes in both perfect and imperfect crystals is developed from basic classical and quantum mechanical principles.

Mr. Littlejohn

EE 533 TRANSISTOR CIRCUITS 3(3-0) F

Prerequisites: EE 314, B average in EE and MA

A study of the application of transistors to linear and switching circuitry. The electrical response of such systems is considered in the light of certain physical characteristics of the transistor, in addition to the piecewise linear model. Device characteristics, temperature stability, cascaded amplifiers and elementary switching circuits are treated.

Mr. Manning

EE 591, 592 SPECIAL TOPICS IN ELECTRICAL ENGINEERING 3(3-0) FS

Prerequisite: B average in technical subjects

A two-semester sequence to develop new courses and to allow qualified students to explore areas of special interest.

Graduate Staff

FOR GRADUATES ONLY

EE 611, 612 ELECTRIC NETWORK SYNTHESIS 3(3-0) FS

Prerequisite: EE 504

A study of modern network theory, with the emphasis on synthesis of both passive and active networks based on the work of Brune, Bode, Guillemin, Bott and Duffin, Darlington, Foster, Linville, Piloty and many others. Both the realization problem and the approximation problem will be treated.

Messrs. Christian, Hoadley

EE 613, 614 ADVANCED FEEDBACK CONTROL**3(3-0) FS****Prerequisite: EE 516**

An advanced study of feedback systems for the control of physical variables. Follower systems and regulators. Mathematical and graphical description of systems. Frequency response and root locus methods for compensation and design. Stability theory and performance criteria. The state variable concept. Continuous and discrete systems. Analysis of nonlinear systems.

Mr. Peterson**EE 615 ELECTROMAGNETIC WAVES****3(3-0) S****Prerequisite: EE 507**

Maxwell's equations applied to a study of the propagation of energy by electromagnetic waves. Vector and scalar retarded potentials, propagation in free space and material media, guided electromagnetic waves, common waveguides, skin effect, resonant cavities. Microwave network theory applied to measurement problems.

Messrs. Barclay, Tischer**EE 616 MICROWAVE ELECTRONICS****4(3-3) F****Prerequisite: EE 615**

Frequency limitations of conventional electron tubes. Microwave power generation and control by interaction of electromagnetic fields with charged particles and molecular energy levels, and by nonlinear reactances. Applications in klystrons, magnetrons, traveling-wave tubes, masers and reactance amplifiers. Measurement problems and techniques in microwave region.

Mr. Barclay**EE 617 PULSE, SWITCHING AND TIMING CIRCUITS****3(3-0) S****Prerequisites: EE 503, EE 512**

Tube and transistor circuit techniques for the production, shaping and control of nonsinusoidal wave forms. Fundamental circuits needed in pulse information systems, instrumentation and computers.

Mr. Barclay**EE 618 ANTENNAS AND RADIATION****4(3-3) S****Prerequisite: EE 615**

Electromagnetic wave theory applied to radiating elements. Radiation from a small current element and multipoles. Arbitrary radiation fields. Radiation characteristics, gain, beamwidth, sidelobe levels of antennas. The reciprocity theorem, scattering, effective aperture and antenna temperature will be treated related to receiving type antennas.

Messrs. Rhodes, Tischer**EE 619 GUIDED WAVES AND RESONATORS****3(3-0) S****Prerequisite: EE 615**

A study related to guided waves and resonators with emphasis on microwaves and millimeter waves. The effect of boundaries on wave propagation and the means of guiding waves will be discussed from a general viewpoint beginning with electromagnetic waves. The analogies with other types of waves such as acoustic and plasma waves will be considered. Nonconventional waveguide concepts. General relationships for resonators and for their incorporation in communication systems will be derived.

Messrs. Barclay, Tischer**EE 623 ELECTRONIC PROPERTIES OF SOLID-STATE MATERIALS****3(3-0) F****Prerequisite: EE 532****Corequisite: PY 501**

A study of the electronic properties of solids. The energy levels of electrons in molecules and crystals will be discussed as well as the energy states of crystal

impurities and defects. The importance of all these in carrier transport and recombination of excess carriers will be discussed. Optical properties and hot electron effects in solid-state materials will also be treated.

Mr. Hauser

EE 624 ELECTRONIC PROPERTIES OF SOLID-STATE DEVICES 3(3-0) S
Prerequisite: EE 532

A study in detail of the static and dynamic terminal properties of a large class of solid-state devices. Boundary relationships at solid-state interfaces will be considered in considerable depth along with the determination of added carrier profiles in neutral and nonneutral bulk regions. The present technology of device fabrication will be discussed and demonstrated.

Mr. Hauser

EE 641 ADVANCED DIGITAL COMPUTER THEORY 3(3-0) S
Prerequisite: EE 520

A study of the circuits and components of modern digital computers, including basic logic systems, codes, advanced systems of circuit logic, vacuum tube, transistor and magnetic components. Memory devices, counters, converters, adders, accumulators, inputs, outputs and computer control systems will be analyzed.

Mr. Bell

EE 642 AUTOMATA AND ADAPTIVE SYSTEMS 3(3-0) F
Prerequisite: EE 520

The study of neural nets in natural systems, artificial nerve nets, pattern-recognition devices, artificial intelligence, goal-directed behavior, self-repairing machines, the logic of automata and adaptive Boolean logic.

Mr. Bell

EE 643 ADVANCED ELECTRICAL MEASUREMENTS 3(3-0) S
Prerequisites: EE 431, EE 503

A critical analysis of circuits used in electrical measurements, with special attention to such topics as balance convergence, effects of strays, sensitivity, the use of feedback in electronic devices, automatic measuring systems and digital measuring systems.

Mr. Hoadley

EE 645, 646 ADVANCED ELECTROMAGNETIC THEORY 3(3-0) FS
Prerequisites: EE 615 or PY 503, MA 512

A comprehensive study of electromagnetic theory with emphasis on field theory applications. Changes in both uniform and accelerated motion, field equivalence principles, anisotropic media, ferrite media, variational methods for waveguide discontinuities, periodic structures including Floquet's theorem, integral transform and function-theoretical techniques, solid-state theory applied to quantum electronic devices.

Mr. Itoh

EE 651 STATISTICAL COMMUNICATION THEORY 3(3-0) S
Prerequisites: EE 401 or EE 503; EE 512 or MA 541

Generalized waveform analysis including Fourier Transforms, correlation functions and other statistical descriptions of stationary random processes; manipulation of signal descriptions as affected by linear time-invariant networks; derivation of the optimum impulse response and transfer function of the general linear operator; optimum filter synthesis by the use of ortho-normal functions; problems to illustrate the applications of the theory.

Mr. O'Neal

EE 653 FUNDAMENTALS OF SPACE COMMUNICATIONS 3(3-0) F
Prerequisite: EE 615

An analytical study of communications related to space operations with emphasis on electromagnetics and antennas. Wave propagation along the trans-

mission path in nonuniform and nonisotropic media. Ionospheric propagation and plasma sheath effects. Antenna characteristics for space operations on ground and on vehicles. Large surface radiators, phased arrays and low noise structures. Vehicle-born antennas. Problems of signal transmission. Communications by lasers.

Mr. Tischer

EE 655 WAVE PHENOMENA IN PLASMA

3(3-0) F

Prerequisite: EE 615

An advanced analysis of wave phenomena and oscillations in plasma. Electron and ion orbits, plasma characteristics and their derivations. Statistical particle dynamics and wave interaction. Macroscopic theory of field interactions. Oscillations and waves, Landau damping. Relativistic effects. Wave propagation in and radiation from stationary and moving plasma.

Mr. Tischer

EE 691, 692 SPECIAL STUDIES IN ELECTRICAL ENGINEERING

3(3-0) FS

This course provides an opportunity for small groups of advanced graduate students to study advanced topics in their special fields of interest under the direction of qualified members of the professional staff.

Graduate Staff

EE 695 ELECTRICAL ENGINEERING SEMINAR

1(1-0) FS

Prerequisite: Graduate standing in electrical engineering

A series of papers and conferences participated in by the instructional staff, invited guests and students who are candidates for advanced degrees.

Graduate Staff

EE 699 ELECTRICAL ENGINEERING RESEARCH

Credits Arranged

Prerequisites: Graduate standing in electrical engineering, consent of advisor

Graduate Staff

ENGINEERING MECHANICS

GRADUATE FACULTY

Professor PATRICK H. McDONALD, *Head*

Professors: TIEN-SUN CHANG, ROBERT A. DOUGLAS, *Associate Head*, ADOLPHUS MITCHELL; *Associate Professors:* WILLIAM L. BINGHAM, MAURICE H. CLAYTON, JOHN A. EDWARDS, JOHN F. ELY, VERNON E. HOLT, CLARENCE J. MADAY; *Assistant Professor:* EDWARD D. GURLEY

The Department of Engineering Mechanics offers graduate programs leading to the Master of Science and the Doctor of Philosophy degrees. The faculty of the department offers a broad range of graduate courses both for its own students seeking advanced degrees and for inclusion in the graduate programs of students in allied areas of engineering and in the physical and mathematical sciences.

Graduate studies in engineering mechanics embrace several broad areas including fluid mechanics, solid mechanics, continuum mechanics, dynamics and structural mechanics. Each of these areas is of considerable importance in current research. Professional interests of the faculty are represented by courses devoted to the elastic and plastic behavior of solids, viscous and compressible fluid flow, the generalized behavior of matter when described as a continuum, and in sequences devoted to the theory of periodic and aperiodic vibrations and to space mechanics.

Courses for individual programs may be chosen rather broadly from the listings indicated, and special attention is directed to the reservoir of courses appropriate to mechanics studies, selected from closely allied engineering specialties. Beginning graduate students ordinarily will choose a program to encompass several of the major areas, thus establishing a broad base for subsequent studies at the advanced graduate level, usually concentrated about one particular area of research.

Interdisciplinary graduate programs in the areas of mechanics, electro-technics, and materials are encouraged.

Graduate research in mechanics in any of the major areas outlined may follow the lines of either analytical or experimental investigations. The development of new research techniques for both types of endeavor is of prime concern to the field of mechanics and the laboratory complex of engineering mechanics includes a number of research laboratories. One of these is equipped for dynamic studies in viscoelasticity, one for research in fracture mechanics and another for static and dynamic studies in stress concentration. Whether a student is inclined toward analytical or toward experimental investigations, he ordinarily will gain experience in both types of endeavor prior to his independent research activity.

FOR GRADUATES AND ADVANCED UNDERGRADUATES

EM 501, 502 CONTINUUM MECHANICS I, II 3(3-0) FS

Prerequisites: EM 301, EM 303, MAE 301, MA 405

The concepts of stress and strain are presented in generalized tensor form. Emphasis is placed on the discussion and relative comparison of the analytical models for elastic, plastic, fluid, viscoelastic, granular and porous media. The underlying thermodynamic principles are presented, the associated boundary value problems are formulated and selected examples are used to illustrate the theory.

Mr. Chang

EM 503 THEORY OF ELASTICITY I 3(3-0) F

Prerequisite: EM 301

Corequisite: MA 511 or MA 401

The fundamental equations governing the behavior of an elastic solid are developed in various curvilinear coordinate systems. Plane problems, as well as the St. Venant Problem of Bending, Torsion and Extension of bars are covered. Displacement fields, stress fields, Airy and complex stress functions are among the methods used to obtain solutions.

Messrs. Douglas, Ely

EM 504 MECHANICS OF IDEAL FLUIDS 3(3-0) F

Prerequisite: EM 304

Corequisite: MA 513

Basic equations of ideal fluid flow; potential and stream functions; vortex dynamics; body forces due to flow fields, methods of singularities in two-dimensional flows; analytical determination of potential functions; conformal transformations; free-streamline flows.

Messrs. Amein, Edwards, Holt

EM 505 MECHANICS OF VISCOUS FLUIDS I 3(3-0) S

Prerequisite: EM 304

Corequisite: MA 532

Equations of motion of a viscous fluid (Navier-Stokes Equations); general properties of the Navier-Stokes equations; some exact solutions of the Navier-

Stokes equations; boundary layer equations; some approximate methods of solution of the boundary layer equations; laminar boundary layers in axisymmetric and three-dimensional flows; unsteady laminar boundary layers.

Messrs. Amein, Edwards, Holt

EM 506 MECHANICS OF COMPRESSIBLE FLUIDS I 3 (3-0) S

Prerequisites: EM 304, MAE 302

Corequisite: MA 532

Introduction to compressible fluid flow; isentropic, one-dimensional flow; Rayleigh and Fanno line flows; generalized one-dimensional flow; normal shock waves; introduction to multidimensional, compressible flow.

Mr. Edwards

EM 507 SYSTEMS ANALYSIS 3 (3-0) F

Prerequisites: EM 301, EM 303, MA 511

A course in the design of engineering systems in which mechanics dominates.

Mr. McDonald

EM 508 SYSTEMS SYNTHESIS 3 (3-0) S

Prerequisite: EM 507

A course in the design of engineering systems in which mechanics dominates.

Mr. McDonald

EM 509 SPACE MECHANICS I 3 (3-0) F

Prerequisites: EM 302, EM 304

Corequisite: MA 511

The application of mechanics to the analysis and design of orbits and trajectories. Trajectory computation and optimization; space maneuvers; reentry trajectories; interplanetary guidance.

Messrs. Clayton, Maday

EM 510 SPACE MECHANICS II 3 (3-0) F

Prerequisites: EM 509, MA 511

Continuation of EM 509. The analysis and design of guidance systems. Basic sensing devices; the characteristics of an inertial space; the theory of stabilized platforms; terrestrial inertial guidance.

Messrs. Clayton, Maday

EM 511 THEORY OF PLATES AND SHELLS 3 (3-0) F

Prerequisites: EM 301, MA 511

Bending theory of thin plates; geometry of surfaces and stresses in shells. Various methods of analysis are discussed and illustrated by problems of practical interest.

Mr. McDonald

EM 521 PROPERTIES OF SOLIDS 3 (3-0) F

Prerequisites: EM 301, MIM 201, PY 407

Atomic and molecular principles are applied toward an introductory understanding of macroscopic material properties. The concept of the grand canonical ensemble average of atomic behavior is employed to unify the characterization and interrelationships of material properties. Finally, phenomenological behaviors and coupled effects are described within the continuum concept.

Mr. Holt

EM 551 ADVANCED STRENGTH OF MATERIALS 3 (3-0) F

Prerequisite: EM 301

Stresses and strains at a point; rosette analysis; stress theories, stress concentration and fatigue; plasticity; inelastic, composite and curved beams; prestress energy methods; shear deflections; buckling problems and column design; and membrane stresses in shells.

Mr. Gurley

EM 552 ELASTIC STABILITY 3(3-0) S
 Prerequisites: EM 551, MA 301, MA 405

A study of elastic and plastic stability. The stability criterion as a determinant. The energy method and the theorem of stationary potential energy. The solution of buckling problems by finite differences and the calculus of variations. The application of successive approximations to stability problems. Optimization applied to problems of aeroelastic and civil engineering structures. Mr. Gurley

EM 555 DYNAMICS I 3(3-0) F
 Prerequisites: EM 301, MA 405

The theory of vibrations from the Lagrangian formulation of the equations of motion. Free and forced vibrations with and without damping, multiple degrees of freedom, coupled motion, normal mode vibrations, wave propagation in solid bodies. Messrs. Clayton, Maday

EM 556 DYNAMICS II 3(3-0) S
 Prerequisites: EM 301, MA 405

The dynamics of particles and rigid bodies by the use of formulations of the laws of mechanics due to Newton, Euler, Lagrange and Hamilton. Accelerated reference frames, constraints, Euler's angles, the spinning top, the gyroscope, precession, stability, phase space and nonlinear oscillatory motion. Messrs. Clayton, Maday

FOR GRADUATES ONLY

EM 601, 602 UNIFYING CONCEPTS IN MECHANICS I, II 3(3-0) FS
 Prerequisite: PY 601

Generalized treatment of the fundamental equations and boundary value problems of continuous and noncontinuous media. Use is made of contemporary developments in irreversible thermodynamics, statistical mechanics and electrodynamics to provide a unified foundation for the development of principles governing the dynamic and thermodynamic behavior of elastic, plastic and viscoelastic solids, viscous fluids and rheological media. Messrs. Chang, McDonald

EM 603 THEORY OF ELASTICITY II 3(3-0) S
 Prerequisite: EM 503
 Corequisite: MA 513

An extension of EM 503 to include the Cauchy Integral methods for plane problems, three-dimensional problems, variational methods and the use of numerical methods. Messrs. Douglas, Ely

EM 604 THEORY OF PLASTICITY 3(3-0) S
 Prerequisite: EM 503

Analytical models are developed to represent the behavior of deformable solids in the plastic regime. Conditions of yielding and fracture which initiate and terminate plastic behavior are studied, with the special stress-strain relationships necessary in plasticity. The hyperbolic equations of slipline fields characteristic of plane strain theory are developed. Mr. Bingham

EM 611 MECHANICS OF COMPRESSIBLE FLUIDS II 3(3-0) S
 Prerequisite: EM 506

Continuation of EM 506, linearized theory of two-dimensional flow, method of characteristics for two-dimensional supersonic flow, oblique shock waves, unsteady one-dimensional flow, shock-wave boundary layer interactions and transonic flow. Mr. Edwards

EM 612 MECHANICS OF VISCOUS FLUIDS II**3(3-0) F****Prerequisite:** EM 505

Continuation of EM 505, phenomenological theories of turbulence, turbulent flow in ducts and pipes, turbulent boundary layer with and without pressure gradient, compressible boundary layer, boundary layer control and free viscous flow.

Messrs. Amein, Edwards**EM 621 PROPERTIES OF MATERIALS AT LOW TEMPERATURES****3(3-0) FS****Prerequisites:** EM 301, EM 521 or equivalent

Recent developments in low-temperature theory and applications of materials are presented starting with the theory of atomic processes which govern low-temperature behavior. A study of the current models of the dominant physical processes at low temperatures is applied to mechanical, thermal and electrical behavior, including superconductivity and superfluidity. Results are applied toward prediction and correlation of properties at higher temperatures where the governing physical processes are more interrelated.

Mr. Holt**EM 641 OPTICAL MECHANICS****3(2-3) S****Prerequisite:** EM 402 or MAE 516

Concepts of crystal optics applied to continua deformed statically or dynamically by mechanical or thermal loading; optical interference and its use as a measuring technique of absolute and relative retardations in various types of interferometers; relative retardation measurements; deformation measurements with diffraction gratings; Moire (mechanical) interference measurements.

Mr. Bingham**EM 656 NONLINEAR VIBRATIONS****3(3-0) FS****Prerequisite:** EM 555

Free and forced vibrations of systems with nonlinear restoring forces and self-sustained oscillations. Approximation techniques applied to nonlinear differential equations. Comparison with exact solutions when possible. Emphasis placed on understanding properties unique to nonlinear systems.

Mr. Clayton**EM 695 EXPERIMENTAL METHODS IN MECHANICS****3(2-3) S****Prerequisite:** Consent of instructor

A study of specialized experimental techniques utilized in contemporary research in the areas of mechanics.

Messrs. Bingham, Douglas, Edwards**EM 697 SEMINARS IN MECHANICS****1(1-0) FS****Prerequisites:** Graduate standing, consent of advisor

The discussion and development of theory relating to contemporary research in the frontier areas of mechanics.

Messrs. Gurley, Maday**EM 698 SPECIAL TOPICS IN MECHANICS****Credits Arranged**

The study, by small groups of graduate students under the direction of members of the faculty, of topics of particular interest in various advanced phases of mechanics.

Graduate Staff**EM 699 RESEARCH IN MECHANICS****Credits Arranged**

Individual research in the field of mechanics.

Graduate Staff

ENGLISH

GRADUATE FACULTY

Professor LODWICK HARTLEY, *Head*

Professors: HENDERSON G. KINCHELOE, BENJAMIN G. KOONCE, JR., FRANK H. MOORE, GUY OWEN, JR., RICHARD WALSER; *Associate Professors:* LARRY S. CHAMPION, EDMUND P. DANDRIDGE, JR., MAX HALPEREN, ALBERT S. KNOWLES, JR., WILLIAM B. TOOLE, III, PORTER WILLIAMS, JR.

The Department of English offers instruction leading to the Master of Arts degree with specialization in English and American literature. The program is designed either to provide the student with a terminal course of study or to serve as the first year toward a doctorate.

A minimum of 30 semester hours of graduate credit is required, though the program may be expanded to meet individual student situations.

Assistantships for promising students are available. These students will take ENG 504 in the fall semester and devote half-time during two semesters to the teaching of courses in freshman composition under supervision.

FOR GRADUATES AND ADVANCED UNDERGRADUATES

ENG 504 PROBLEMS IN COLLEGE COMPOSITION 3(3-0) F

Prerequisite: Consent of instructor or graduate standing

Directed study of the development of rhetorical skills in composition in classroom situations. Mr. Walser

ENG 524 MODERN ENGLISH USAGE 3(3-0) S

Prerequisite: Consent of instructor or graduate standing

An intensive study of English grammar, with attention to new developments in structural linguistics and with emphasis on current usage. Mr. Dandridge

ENG 526 HISTORY OF THE ENGLISH LANGUAGE 3(3-0) F

Prerequisite: Consent of instructor or graduate standing

A survey of the growth and development of the language from its Indo-European beginnings to the present. Mr. Koonce

ENG 551 CHAUCER 3(3-0) F

Prerequisite: ENG 261 or equivalent

The intensive reading and analysis of Chaucer's major works, with attention to linguistic problems. Mr. Koonce

ENG 561 MILTON 3(3-0) S

Prerequisite: ENG 261 or equivalent

An intensive reading of Milton with attention to background materials in the history and culture of seventeenth-century England. Mr. Moore

ENG 562 THE EIGHTEENTH CENTURY 3(3-0) F

Prerequisite: ENG 261 or equivalent

The major figures in English literature between 1660 and 1790 against the background of social, cultural and religious change. Mr. Hartley

ENG 575 SOUTHERN WRITERS**3(3-0) S****Prerequisite:** ENG 265-266 or equivalent

A survey of the particular contribution of the South to American literature, with intensive study of selected major figures.

Mr. Kincheloe**ENG 578 ENGLISH DRAMA****3(3-0) S****Prerequisite:** ENG 261-262 or equivalent

Intensive study of the English drama from the beginnings to 1800.

Mr. Champion**FOR GRADUATES ONLY****ENG 608 BIBLIOGRAPHY AND METHODOLOGY****3(3-0) F****Prerequisite:** Graduate standing

A course intended to provide the student with the materials of literary research and scholarship, to introduce him to varying scholarly approaches to literary problems, and to develop his ability to evaluate and use with discrimination the work of scholars in his field.

Mr. Champion**ENG 659 STUDIES IN SHAKESPEARE****3(3-0) S****Prerequisite:** ENG 485 or equivalent

An intensive study—textual and critical—of a limited group of Shakespearean plays requiring independent research.

Mr. Champion**ENG 690 LITERARY CRITICISM****3(3-0) S****Prerequisite:** Graduate standing

An examination of the critical process as it leads to the definition and analysis of literature, together with attention to the main literary traditions and conventions.

Messrs. Halpern, Williams**ENG 692 SPECIAL TOPICS IN AMERICAN LITERATURE****Maximum 6 FS****Prerequisite:** Consent of seminar chairman

An intensive study, involving independent research and centering on some limited topic from American literature.

Graduate Staff**ENG 693 SPECIAL TOPICS IN ENGLISH LITERATURE****Maximum 6 FS****Prerequisite:** Consent of seminar chairman

An intensive study, involving independent research and centering on some limited topic from English literature.

Graduate Staff**ENG 699 RESEARCH IN LITERATURE (Thesis)****Credits Arranged****Prerequisite:** Consent of graduate advisor

Independent investigation of an advanced literary or linguistic problem leading to the writing of a master's thesis.

ENTOMOLOGY**GRADUATE FACULTY***Professor* **ERNEST HODGSON, Acting Head**

Professors: **CHARLES H. BRETT, FRANK E. GUTHRIE, WALTER J. MISTRIC, JR., ROBERT L. RABB, CLYDE F. SMITH, DAVID A. YOUNG, JR.;** *Professor Emeritus:* **THEODORE B. MITCHELL;** *Adjunct Professors:* **LOUIS M**

RUSSELL, REECE I. SAILER, DAVID S. WRAY, JR.; *Associate Professors*: RICHARD C. AXTELL, WILLIAM V. CAMPBELL, WALTER C. DAUTERMAN, MAURICE H. FARRIER, HERBERT H. NEUNZIG, THOMAS J. SHEETS, CHARLES G. WRIGHT, ROBERT T. YAMAMOTO; *Adjunct Associate Professors*: ALBERT L. CHASSON, EDGAR W. CLARK; *Extension Associate Professor*: GERALD T. WEEKMAN; *Assistant Professors*: JULIUS R. BRADLEY, JR., WAYNE M. BROOKS, GEORGE C. ROCK

ASSOCIATE MEMBER OF THE DEPARTMENT

Professor: ALEXANDER R. MAIN

The Department of Entomology offers graduate training leading to the Master of Science and Doctor of Philosophy degrees. The major areas for specialization are physiology, toxicology, ecology, behavior, nutrition, taxonomy, economic entomology, medical and veterinary entomology and pathology.

The department is particularly well qualified to provide intensive training in areas requiring support by allied disciplines. The department is a participant in the program of the Institute of Biological Sciences (see page 18) and the departmental staff includes members of the faculty of physiology, biochemistry and cell biology.

The extensive program of research, supported by federal granting agencies, industry and the University, provides opportunities for graduate training through actual participation in research.

Opportunities exist for training in both applied and fundamental phases of entomology. The applied phases are strongly influenced by the state's agriculture, in which tobacco, cotton, peanuts, livestock and forestry are important components. A cooperative arrangement with the School of Forest Resources provides for majors in forest entomology.

Training in fundamental phases centers around programs such as the synthesis of lipids, comparative biochemistry, enzymology, toxicology, sensory behavior and nutrition. The program in medical and veterinary entomology provides the opportunity for training in minor subjects at the School of Public Health at the University of North Carolina at Chapel Hill.

The research program is supported by a complex of modern departmental facilities, including seven recently completed biotron units, four laboratories for biochemical research, together with supporting greenhouses and rearing rooms. The extensive facilities of the Nuclear Reactor Project are also available for support of departmental projects. Other on-campus research facilities are available, as well as some others in the Research Triangle area.

The student is given wide latitude in the selection of his major and minor subjects from the varied programs offered. Stress is placed on development of independent thought, broad training in fundamentals and mastery of investigative techniques.

FOR ADVANCED UNDERGRADUATES

ENT 401 LITERATURE OF BIOLOGY

1(1-0) F

Prerequisite: Enrollment as upperclassman, undergraduate or graduate

A general course intended to acquaint students with literature problems

of the scientist, mechanics of the library book classifications, bibliographies, abstract journals, taxonomic indexes and preparation of scientific papers in agriculture, forestry, biology and their subdivisions. Mr. Farrier

FOR GRADUATES AND ADVANCED UNDERGRADUATES

ENT 502 FUNDAMENTALS OF ENTOMOLOGY A 5(2-6) F
Prerequisites: Twelve hours in biology, ENT 301 or ENT 312, or equivalent

An intensive treatment of the general external morphology of insects and a survey of the adults and immatures of the orders and principal families of insects with attention to their biology. Messrs. Neunzig, Rabb, Young

ENT 503 FUNDAMENTALS OF ENTOMOLOGY B 5(3-6) S
Prerequisites: Twelve hours in biology, nine hours in chemistry, ENT 301 or equivalent

Structure and morphological variations of organ systems in insects including considerations of their histology and function. Sensory physiology and behavior will then lead into the basic elements of insect behavior.

Messrs. Campbell, Hodgson, Yamamoto, Young

ENT 504 INSECT MORPHOLOGY 3(1-4) F
Prerequisite: ENT 502

Concerned with external morphology, primary and comparative phases, with emphasis on knowledge and techniques which can be applied to specific problems. (Offered fall of 1967-68 and alternate years.) Mr. Young

ENT 511 SYSTEMATIC ENTOMOLOGY 3(1-4) F
Prerequisite: ENT 301 or ENT 312 or equivalent

A somewhat detailed survey of the orders and families of insects, designed to acquaint the student with those groups and develop in the student some ability in the use of keys, descriptions, etc. (Offered fall of 1968-69 and alternate years.)

Mr. Young

ENT 531 INSECT ECOLOGY 3(2-2) F
Prerequisite: ENT 502 or ENT 503 or equivalent

The environmental relations of insects, including insect development, habits, distribution and abundance. (Offered fall of 1967-68 and alternate years.)

Mr. Rabb

ENT 541 IMMATURE INSECTS 2(1-3) F
Prerequisite: ENT 502 or equivalent

An advanced study of the immature stages of selected orders of insects with emphasis on generic and specific taxa. Primary consideration is given to the larval stage, but a brief treatment of eggs and pupae is also included. (Offered fall of 1968-69 and alternate years.) Mr. Neunzig

ENT 550 FUNDAMENTALS OF INSECT CONTROL 3(3-0) F
Prerequisites: ENT 312 or ENT 301 and senior standing

The course is divided into two phases. The first deals with the basic causes of insect problems, an evaluation of the biological and economic aspects of insect attack and the fundamental methods employed in insect control. The second part deals with the critical chemical, physical and biological properties of compounds

used for insect control. The material presented in the course is directed toward obtaining fundamental knowledge of the scientific principles underlying modern methods of protection of food, clothing, shelter and health from arthropods.

Mr. Guthrie

ENT 551 FUNDAMENTALS OF INSECT CONTROL LABORATORY 2(0-4) F
Prerequisite: ENT 550

A laboratory course designed to supplement ENT 550. The student will be introduced to specific insect problems including recognition and evaluation of damage. Practical procedures for design of field plots and statistical procedures for sampling pest management practices will be included. Selected laboratory experiments and demonstrations will include determination of the LD-50, cholinesterase inhibition, residue analysis, mass rearing and evaluation of application equipment.

Mr. Guthrie

ENT 552 APPLIED ENTOMOLOGY 3(1-4) S
Prerequisites: ENT 502, ENT 503, ENT 551

A course dealing with the organization of the field of applied entomology, the significance of other disciplines, research and extension methods, the concept of integrated control and the solution of economic problems. (Offered spring of 1967-68 and alternate years.)

Mr. Mistic

ENT 572 FOREST ENTOMOLOGY 3(2-2) S
Prerequisite: ENT 301 or ENT 312

A study of the methods of identification of forest pests, the factors governing their abundance, habits and control. (Offered spring of 1967-68 and alternate years.)

Mr. Farrier

ENT 582 (ZO 582) MEDICAL AND VETERINARY ENTOMOLOGY 3(2-3) S
Prerequisites: ENT 301 or ENT 312; ZO 581 or equivalent

A study of the morphology, taxonomy, biology and control of the arthropod parasites and disease vectors of man and animals. The ecology and behavior of vectors in relation to disease transmission and control will be emphasized. (Offered spring of 1967-68 and alternate years.)

Mr. Axtell

ENT 590 SPECIAL PROBLEMS Credits Arranged FS
Prerequisites: Graduate standing, consent of instructor

Original research on special problems in entomology not related to a thesis problem, but designed to provide experience and training in research.

Graduate Staff

ENT 592 ACAROLGY 3(2-3) S
Prerequisite: ENT 301 or ENT 312 or ZO 201

A systematic survey of the mites and ticks with emphasis on identification, biology and control of the more common and economic forms attacking material, plants and animals including man. (Offered spring of 1968-69 and alternate years.)

Mr. Farrier

FOR GRADUATES ONLY

ENT 602 PRINCIPLES OF TAXONOMY 3(1-4) S
Prerequisite: ENT 511

A course introducing the methods and tools used in animal taxonomy, designed to promote a better understanding of taxonomic literature, and provide a foundation for taxonomic research. (Offered spring of 1967-68 and alternate years.)

Mr. Young

ENT 611 BIOCHEMISTRY OF INSECTS**3(3-0) F****Prerequisite:** CH 551 or equivalent

The biochemistry of insects will be considered with primary emphasis on intermediate metabolism. Aspects in which insects show specialization will be treated in greater detail. The comparative treatment used necessitates some consideration of other animal groups. (Offered fall of 1968-69 and alternate years.)

Mr. Hodgson**ENT 622 INSECT TOXICOLOGY****3(2-3) S****Prerequisites:** ENT 551, CH 551 or equivalent

The relation of chemical structure to insect toxicity, the mode of action of toxicants used to kill insects, the metabolism of insecticides in plant and animal systems, the selectivity within the cholinesterase inhibitors and other selective mechanisms and the analysis of insecticide residues will be discussed. (Offered spring of 1967-68 and alternate years.)

Messrs. Dauterman, Guthrie**ENT 690 SEMINAR****1(1-0) FS****Prerequisite:** Graduate standing in entomology or closely allied fields

Discussion of entomological topics selected and assigned by seminar chairman.

Graduate Staff**ENT 699 RESEARCH****Credits Arranged FS****Prerequisite:** Graduate standing in entomology or closely allied fields

Original research in connection with thesis problem in entomology.

Graduate Staff

EXPERIMENTAL STATISTICS

GRADUATE FACULTY

Professor **DAVID D. MASON, Head**

Professors: ROBERT G. D. STEEL, *Graduate Administrator*, ANTHONY F. BARTHOLOMAY, COLUMBUS C. COCKERHAM, ARNOLD H. E. GRANDAGE, ROBERT J. HADER, DON W. HAYNE, HENRY L. LUCAS, JR., FRANCIS E. McVAY, ROBERT J. MONROE, CHARLES H. PROCTOR, DON L. RIDGEWAY, JACKSON A. RIGNEY, RALPH W. STACY, HUBERTUS R. VAN DER VAART, THOMAS D. WALLACE, OSCAR WESLER; *Visiting Professor:* MELVIN W. CARTER; *Adjunct Professors:* ALVA L. FINKNER, WALTER A. HENDRICKS, DANIEL G. HORVITZ; *Professor Emeritus:* GERTRUDE M. COX; *Associate Professors:* BIBHUTI B. BHATTACHARYYA, HARVEY J. GOLD, LAURENCE J. HERBST, LAURENCE A. NELSON, CHARLES P. QUESENBERRY, JOHN O. RAWLINGS, JERRY A. WARREN; *Adjunct Associate Professors:* DAVID W. GAYLOR, WILLIAM A. GLENN; *Assistant Professors:* MONICA L. CHANG, ARDELL C. LINNERUD, JOHN L. WASIK

The Department of Experimental Statistics offers work leading to the Master of Science, Master of Experimental Statistics (nonthesis) and Doctor of Philosophy degrees. This department has a working arrangement with the Department of Biostatistics in the University of North Carolina's School of Public Health at Chapel Hill, whereby graduate students can

major in experimental statistics and minor in the Division of Health Affairs. The Department of Experimental Statistics maintains a close liaison with the Department of (Mathematical) Statistics at Chapel Hill in order to supplement the offerings in statistical theory. (See University of North Carolina at Chapel Hill courses listed below.) Introductory courses in the three departments are coordinated so that it is easy for a beginning statistics graduate student to transfer from one institution of the Consolidated University to another. The three departments are affiliated with the Institute of Statistics (see page 19). Some doctoral theses in experimental statistics are directed by members of the graduate faculty of the two statistics departments at Chapel Hill.

Members of the department conduct research in biomathematics, nonlinear systems, time series and spectral analysis, operations research, probability and stochastic processes, nonparametric inference, the development of statistical theory and techniques of design and analysis for surveys and experiments, and the development of physical and biological stochastic models. At least one staff member consults with researchers in each of the following fields and conducts his own research on statistical problems which are encountered: the various agricultural sciences, quantitative genetics, wildlife science (game and fish), industrial development and engineering, physical sciences, and social sciences and economics.

A graduate student who majors in experimental statistics may specialize in any one of these fields, with his minor in the associated departments, or with a strong mathematical background he may prefer to minor in mathematics or mathematical statistics. For the graduate student who wishes to minor in statistics, the department has developed a curriculum tailored to his needs. Many employers are offering added inducements for research personnel who have such a minor. The department cooperates with other graduate departments in order to provide the type of courses needed for their students and to provide a staff to participate in their graduate programs.

A program of training in biomathematics at the doctoral and postdoctoral levels recently has been initiated in the Department of Experimental Statistics. This program requires that the student become well grounded in four areas—mathematics, statistics, physical science and some phase of biology. Fellowships and assistantships are available for doctoral students and several fellowships for postdoctorals. Mathematical biology and related areas are now developing rapidly and there is much opportunity for properly trained people.

The department is also cooperating with eight other departments at Raleigh and Chapel Hill in the development of a strong minor program in operations research at both the master's and doctoral levels. Details regarding the operations research graduate program are presented on page 208.

In addition to its consulting services, the department provides computer programming and other assistance to the Agricultural Experiment Station staff in close cooperation with the campus Computing Center. This work is currently augmented by a computer facility grant from the National Institutes of Health. The department also provides a desk calculator computing service for sets of data not economical to program for the digital computer. It furnishes several federal agencies, other states and private con-

cerns with research and consulting services on a contract basis. This work supplies live problems on which graduate students may acquire experience and maturity.

The Department of Experimental Statistics is located in a new building convenient to classroom and central library facilities. Ample space for graduate students is provided adjacent to faculty offices. A well-equipped desk computing laboratory is conveniently located in the graduate student area.

The Computing Center is equipped with an IBM System 360-Model 40 computer which serves in a dual capacity simultaneously as a stand-alone computer, and as a teleprocessing terminal unit to the Triangle Universities Computation Center IBM System 360-Model 75 computer. While this is the only high-speed terminal currently planned for the campus, several medium- and low-speed terminals have been or will be installed. Installation of an IBM 1130 computer, which can be used as a telecommunications terminal or as a stand-alone computer, has been installed in the statistics building, where it is convenient for use in computer programming courses and student research. In addition, an Ambilog 200, a hybrid analog-digital computer, has recently been purchased for the biomathematics research and training program, and is also located in the statistics building.

The department has approximately 20 graduate fellowships and assistantships at stipends adjusted to the previous training and experience of the recipients. Included among these have been industrial fellowships, National Science Foundation traineeships, National Aeronautics and Space Agency fellowships, National Institutes of Health fellowships in biomathematics and National Defense Education Act fellowships in econometrics jointly with the Department of Economics. Students who have a major in an applied field and who have a minimum of one year of calculus, or students who have a major in statistics or mathematics are encouraged to apply for these fellowships and assistantships. Students who have no advanced calculus or matrix algebra are advised to make arrangements to take these courses in the summer prior to entrance in the graduate program. If a graduate assistant has a satisfactory course record, he can complete the requirements for the master's degree in two years (in less time if he takes courses during the summer). A graduate assistant with a master's degree in statistics can complete the requirements for the doctorate in two years. Graduate fellows may be able to complete the requirements in somewhat less time.

Most fields of research, development, production and distribution are seeking persons trained in statistical theory and methods. The demand is equally strong from universities, agricultural and engineering experimental stations, national defense agencies, other federal agencies and a wide variety of industrial concerns. There is a need for experimental statisticians with the master's degree as well as for those with the doctorate.

North Carolina State University is represented on the Committee on Statistics of the Southern Regional Education Board. This committee sponsors a continuing series of graduate summer sessions. In 1968, the host institution is Texas A & M University, and the 1969 session is tentatively scheduled for Virginia Polytechnic Institute. Each of the sponsoring institutions will accept the credits earned by students in the summer session as residence

credit. The courses are arranged to provide consecutive work in successive summers. Information regarding these courses may be obtained from the Department of Experimental Statistics or the Dean of the Graduate School.

FOR ADVANCED UNDERGRADUATES

ST 421, 422 INTRODUCTION TO MATHEMATICAL STATISTICS 3(3-0) FS
Prerequisite: MA 202 or MA 212

Elementary mathematical statistics primarily for students not intending to take further work in theoretical statistics. Includes introduction to probability, common theoretical distributions, moments, moment generating functions, sampling distributions (F, t, chi-square), elementary estimation, hypothesis testing concepts, decision theory concepts and elements of general linear model theory.
Staff

FOR GRADUATES AND ADVANCED UNDERGRADUATES

ST 501, 502 BASIC STATISTICAL ANALYSIS 3(3-0) FS
Prerequisite: ST 311 or equivalent or graduate standing

Basic concepts of statistics; random variables, distributions, statistical measures, estimation, tests of significance, analysis of variance, elementary design and sampling, factorial experiments, multiple regression, analysis of discrete data and other topics. Intended primarily for statistics majors and Ph.D. minors and not intended as a service course for other departments.
Mr. Steel

ST 511 EXPERIMENTAL STATISTICS FOR BIOLOGICAL SCIENCES I 3(3-0) FS
Prerequisite: ST 311 or graduate standing

Basic concepts of statistical models and use of samples; variation, statistical measures, distributions, tests of significance, analysis of variance and elementary experimental design, regression and correlation, chi-square.
Graduate Staff

ST 512 EXPERIMENTAL STATISTICS FOR BIOLOGICAL SCIENCES II 3(3-0) FS
Prerequisite: ST 511 or equivalent

Covariance, multiple regression, concepts of experimental design, factorial experiments, individual degrees of freedom, confounded factorial and split plot designs.
Graduate Staff

ST 513 EXPERIMENTAL STATISTICS FOR SOCIAL SCIENCES I 3(3-0) F
Prerequisite: ST 311 or graduate standing

Basic concepts in collection and analysis of data. Variability of sample data, distributions, confidence limits, chi-square, t-test, analysis of variance, regression, correlation, analytic and descriptive surveys, experimental designs.
Mr. McVay

ST 514 EXPERIMENTAL STATISTICS FOR SOCIAL SCIENCES II 3(3-0) S
Prerequisite: ST 513 or equivalent

Extension of basic statistical concepts to social experiments and surveys; sampling from finite populations and estimating using unrestricted, stratified, systematic and multistage selections; analysis of variance continued; multiple regression; covariance; experimental designs.
Mr. Proctor

ST 515, 516 EXPERIMENTAL STATISTICS FOR ENGINEERS 3(3-0) FS
Prerequisite: ST 361 or graduate standing

General statistical concepts and techniques useful to research workers in

engineering, textiles, wood technology, etc. Probability, distributions, measurement of precision, simple and multiple regression, tests of significance, analysis of variance, enumeration data, sensitivity data, life-testing experiments and experimental designs. Mr. Hader

ST 517 APPLIED LEAST SQUARES

3(3-0) F

Prerequisite: ST 502 or equivalent

Use of least squares estimation in developing numerical descriptions with linear models. Regression, analysis of variance and covariance are considered in a unified manner that does not require an extensive statistical background. Emphasis is placed on the application of these techniques to experimental situations and in broadening the range of problems to which they can be applied (particularly in terms of unequal numbers). A computer will be used for some assigned problems such as matrix inversion. (Minors only.) Mr. Warren

ST 531 DESIGN OF EXPERIMENTS

3(3-0)

Prerequisite: ST 502 or equivalent

Review of completely randomized, randomized complete block and Latin square designs, and the basic concepts in the techniques of experimental design. Designs and analysis methods in factorial experiments, confounded factorials, response surface methodology, change-over design, split-plot experiments and incomplete block designs. Examples will be used to illustrate application and analysis of these designs. Mr. Hader

ST 541 (MA 541) THEORY OF PROBABILITY I

3(3-0) F

(See Mathematics, page 178.)

ST 542 (MA 542) THEORY OF PROBABILITY II

3(3-0) S

(See Mathematics, page 178.)

ST 551 BASIC STATISTICAL INFERENCE

3(2-2) F

Prerequisite: MA 511

Corequisite: MA 405

Frequency distributions and moments; sampling distributions; introductory theory of point and interval estimation; tests of hypotheses. Mr. Grandage

ST 552 BASIC THEORY OF LEAST SQUARES AND VARIANCE COMPONENTS

3(2-2) S

Prerequisites: MA 405, ST 551

Theory of least squares; multiple regression; analysis of variance and covariance; experimental design models; factorial experiments; variance component models. Graduate Staff

ST 561 (EC 561) INTERMEDIATE ECONOMETRICS

3(3-0) S

(See Economics, page 103.)

ST 571 (BMA 571, BS 571, MA 571) BIOMATHEMATICS I

3(3-0) F

(See Biomathematics, page 137.)

ST 572 (BMA 572, BS 572, MA 572) BIOMATHEMATICS II

3(3-0) S

(See Biomathematics, page 138.)

ST 591 SPECIAL PROBLEMS

1-3 FS

Development of techniques for specialized cases, particularly in connection with thesis and practical consulting problems. Graduate Staff

U.N.C. ST 111 METHODS OF MATHEMATICAL STATISTICS I 3(3-0) F
Prerequisite: Advanced calculus

Introductory treatment of special mathematical techniques of particular importance in probability and statistics, including topics from combinatorial mathematics, Fourier and Laplace transforms, contour integration, special inequalities and finite differences. Graduate Staff

U.N.C. ST 131 ELEMENTARY PROBABILITY 3(3-0) F
Prerequisite: Advanced calculus

Fundamentals of probability theory and distribution theory essential for the study of mathematical statistics, including: axiomatic treatment of probability models, combinatorial probability, conditional probability and independence, random variables, distribution and density functions, moments and generating functions, combined random variables. Graduate Staff

U.N.C. ST 132 INTERMEDIATE PROBABILITY 3(3-0) S
Prerequisite: U.N.C. ST 131 or ST 134

Laws of large numbers, characteristic functions and central limit theorems. Elements of stochastic processes and their applications, including random walks, Markov chains, recurrent events, Brownian motion and elementary queueing theory. Graduate Staff

U.N.C. ST 134 STATISTICAL THEORY I 5(4-2) F
Prerequisite: Advanced calculus

U.N.C. ST 131 plus regression and correlation theory, convergence and approximation, common distributions, functions of random samples, multinormal theory and random normal sampling. Graduate Staff

U.N.C. ST 135 STATISTICAL THEORY II 3(3-0) S
Prerequisite: U.N.C. ST 131 or ST 134

Fundamentals of statistical inference and statistical decision theory, including: the decision and inference problem, sufficient statistics, point estimation (unbiasedness, Bayes and minimax methods, maximum likelihood and large sample theory), hypothesis testing, interval estimation, chisquare tests and introduction to nonparametric, Bayesian and sequential methods. Linear estimation, analysis of variance and regression are largely excluded. Graduate Staff

U.N.C. ST 150 ANALYSIS OF VARIANCE WITH APPLICATION
TO EXPERIMENTAL DESIGNS 3(3-0) S
Corequisite: U.N.C. ST 135

Linear estimation. Nonestimability. The best linear estimate and its variance. The Gauss-Markov theorem. Sums of squares. Analysis of variance and the generalized t and F tests. Unified mathematical theory of the intrablock analysis of incomplete block designs. Applications to balanced, lattice, partially balanced and Latin square designs. Graduate Staff

U.N.C. ST 170 ORDER STATISTICS 3(3-0) S
Prerequisite: U.N.C. ST 135 or equivalent

Distribution theory of order statistics. Moments, exact and approximate. Estimation of location and scale parameters, censored data. Life-testing and scale parameters, censored data. Life-testing and reliability. Shortcut procedures, quality control. Tests for outliers and slippage. Multiple decision procedures based on order statistics. Asymptotic and extreme-value theory. Graduate Staff

FOR GRADUATES ONLY

ST 606 (MA 606, OR 606) MATHEMATICAL PROGRAMMING II 3(3-0) S
Prerequisite: IE 505 (MA 505)

This course is intended for those who desire to study linear and nonlinear programming from an advanced mathematical point of view. Special attention will be paid to the theoretical and computational aspects of current research problems in the field of mathematical programming, including linear programming and game theory, theory of graphs, discrete linear programming, linear programming under uncertainty and nonlinear programming.

Mr. Bhattacharyya

ST 611, 612 INTERMEDIATE STATISTICAL THEORY 3(3-0) FS
Prerequisites: MA 405, MA 512, ST 551

This course will provide the additional theory, above that of ST 551, needed for many advanced theory courses. Many of the topics of ST 551 will be developed more rigorously, with more attention paid to mathematical aspects. Advanced probability theory; limit theorems, distribution theory, multinormal distributions. Statistical decision theory, theory of estimation, confidence regions, theory of tests of hypotheses, sequential tests, nonparametric methods. Mr. Quesenberry

ST 613 TIME SERIES ANALYSIS I 3(3-0) S
Prerequisite: ST 552

Statistical analysis of realizations of second-order stationary random processes, and mathematical specifications of the underlying processes, with emphasis throughout on the spectrum. Discussions of applications are given to illustrate the theory and methods. Topics include second-order stationary parent sequences, correlation analysis, autoregressive series, moving averages, hidden periodicities models, spectral analysis, estimation of the correlogram and the coefficients of autoregressive schemes, the periodogram, estimation of the spectral density; serial correlation theory, goodness-of-fit tests. Mr. Herbst

ST 614 TIME SERIES ANALYSIS II 3(3-0) F
Prerequisites: ST 542 (MA 542), ST 613

Cross-covariance analysis of two time series, cross-spectral analysis of two time series, estimation of co-spectral density, quadrature-spectral density, coherence and phase, interpretations and applications of coherence analysis, detection and estimation of periodicities in variances of time series, spectral representation theory for second-order stationary processes, further discussion of spectral estimation. Mr. Herbst

ST 617, 618 (MA 617, 618) MEASURE THEORY AND ADVANCED PROBABILITY 3(3-0) FS
Prerequisites: MA 512, MA 541 or equivalent

Modern measure and integration theory in abstract spaces, probability measures, random variables and expectations, conditional probability and conditional expectations, distribution functions, characteristic functions, modes of convergence, weak and strong laws of large numbers, central limit theorems and other limit laws, introduction to stochastic processes. Mr. Wesler

ST 619 (MA 619) TOPICS IN ADVANCED PROBABILITY 3(3-0) F
Prerequisites: ST 617, 618 (MA 617, 618)

Characteristic functions, infinitely divisible and stable laws, factorizations of probability distributions, law of iterated logarithm, random walks, fluctuation

theory, martingales, ergodic theory, Markov processes, the Poisson process, further topics in stochastic processes, applications. Mr. Wesler

ST 621 STATISTICS IN ANIMAL SCIENCE 3(3-0) F
Prerequisite: ST 502 or equivalent

Sources and magnitudes of errors in experiments with animals, experimental designs and methods of analysis adapted to specific types of animal research, relative efficiency of alternate designs, amount of data required for specified accuracy, student reports on selected topics. (Offered fall of 1969-70 and alternate years.) Mr. Lucas

ST 622 (ANS 622) PRINCIPLES OF BIOLOGICAL ASSAYS 3(3-0) S
(See Animal Science, page 63.)

ST 623 STATISTICS IN PLANT SCIENCE 3(3-0) F
Prerequisite: ST 502 or equivalent

Principles and techniques of planning, establishing and executing field and greenhouse experiments. Size, shape and orientation of plots; border effects; selection of experimental material; estimation of size of experiments for specified accuracy; scoring and subjective tests; subsampling plots and yields for laboratory analysis. Mr. Mason

ST 626 (GN 626) STATISTICAL CONCEPTS IN GENETICS 3(3-0) S
Prerequisite: GN 512
Corequisite: ST 502 or equivalent

Factors bearing on rates of change in population means and variances, with special reference to cultivated plants and domestic animals; selection, inbreeding, magnitude and nature of genotypic and nongenotypic variability; experimental and statistical approaches in the analysis of quantitative inheritance. Mr. Cockerham

ST 631 THEORY OF SAMPLING APPLIED TO SURVEY DESIGN 3(3-0) F
Prerequisites: ST 422 or ST 502 or equivalent

Principles for interpretation and design of sample surveys. Biases, variances and costs of estimators. Comparisons among simple random sample, ratio estimation, stratification, varying probabilities of selection, multistage, systematic and cluster sampling, double sampling. Response errors. Mr. Proctor

ST 641 (SOC 641) STATISTICS IN SOCIOLOGY 3(3-0) S
(See Sociology and Anthropology, page 240.)

ST 651 (EC 651) ECONOMETRICS 3(3-0) F
(See Economics, page 105.)

ST 652 (EC 652) TOPICS IN ECONOMETRICS 3(3-0) S
(See Economics, page 105.)

ST 671 ADVANCED TOPICS IN LEAST SQUARES AND VARIANCE COMPONENTS 3(3-0) S
Prerequisites: ST 502 or equivalent, ST 552

Use of nonbalanced designs to estimate variance components; comparison of estimators; problems with finite populations. Least squares procedures for non-standard conditions; unequal variances, correlated errors, nonadditivity, measurement errors, nonnormality. Functional relationships. Factorial experiments with continuous factor levels; incomplete blocks. Mr. Gaylor

ST 672 SPECIAL ADVANCED TOPICS IN STATISTICAL ANALYSIS 3(3-0) F
Prerequisites: ST 502 or equivalent, ST 552

Enumeration data; covariance; nonlinear models; discriminant functions
and other multivariate techniques. Mr. Monroe

ST 674 ADVANCED TOPICS IN CONSTRUCTION AND ANALYSIS
OF EXPERIMENTAL DESIGNS 3(3-0) S

Prerequisites: ST 502 or equivalent, ST 552

Interblock analysis of incomplete block designs, partially balanced designs,
confounding, data collected at several places and times, multiple factor designs,
change-over trials, analysis of groups of means. Graduate Staff

ST 682 STATISTICAL ANALYSIS FOR LINEAR MODELS 3(3-0) F
Prerequisites: ST 502 or equivalent, ST 552

Review of basic least squares, partitioning sums of squares, weighted least
squares; regression coefficients as random variables; models with redundancies,
use of generalized inverses; models with restrictions; applications to dispro-
portionate data, incomplete blocks designs and covariance analysis; arithmetic
items; application to nonlinear models. Mr. Lucas

ST 691 ADVANCED SPECIAL PROBLEMS 1-3 FS
Prerequisites: ST 502 or equivalent, ST 552

Any new advance in the field of statistics which can be presented in lecture
series as unique opportunities arise. Graduate Staff, Visiting Professors

ST 694 SEMINAR 1(1-0) FS
A maximum of two semester hours is allowed toward the master's degree, but
any number toward the doctorate. Graduate Staff

ST 699 RESEARCH Credits Arranged FS
A maximum of nine semester hours is allowed toward the Master of Science de-
gree; no limitation on semester hours in doctorate programs. Graduate Staff

U.N.C. ST 200 APPLIED MULTIVARIATE ANALYSIS I 3(3-0) S
Prerequisite: U.N.C. ST 135

Relations between multiple regression, analysis of variance, multivariate
analysis and factor analysis. Tests with discriminant functions. The generalized
student ratio. Use of roots of determinantal equations. Classification problems.
Distance and group constellations. Graduate Staff

U.N.C. ST 202 METHODS OF OPERATIONS RESEARCH 3(3-0) F
Prerequisite: U.N.C. ST 135

Linear programming, theory of games, techniques for analyzing waiting lines
and queues. Applied probability, recent developments, applications of results to
specific problems. Case studies. (Offered fall of 1968-69 and alternate years.)
Graduate Staff

U.N.C. ST 212 METHODS OF MATHEMATICAL STATISTICS II 3(3-0) S
Prerequisite: Advanced calculus

Measure and integration theory, with special reference to random variables,
distribution functions, probability measures, and including Fubini's Theorem,
the Radon-Nikodym Theorem, conditional probability, conditional expectation and
modes of convergence. Graduate Staff

U.N.C. ST 220 THEORY OF ESTIMATION AND HYPOTHESIS TESTING 4(4-0) F
Prerequisites: U.N.C. ST 132, ST 135, ST 212

Bayes procedures for estimation and testing. Minimax procedures. Sufficient statistics. Optimal unbiased estimators. Most powerful similar tests. Admissibility. Invariance. Confidence sets. Large sample theory. Graduate Staff

U.N.C. ST 221 SEQUENTIAL ANALYSIS 2(2-0) F
Prerequisites: U.N.C. ST 132, ST 135

Hypothesis testing and estimation when the sample size depends on the observations. Sequential probability ratio tests. Sequential design of experiments. Stochastic approximation. Graduate Staff

U.N.C. ST 222 NONPARAMETRIC INFERENCE 3(3-0) S
Prerequisites: U.N.C. ST 132, ST 135, ST 212

Estimation and testing when the functional form of the population distribution is unknown. Rank and sign tests. Tests based on permutations of observations. Power of nonparametric tests. Optimum nonparametric tests and estimators. Nonparametric confidence intervals and tolerance limits. Graduate Staff

U.N.C. ST 231 ADVANCED PROBABILITY 3(3-0) F
Prerequisites: U.N.C. ST 132, ST 212

Advanced theoretic course, including: random variables and expectations, distributions and characteristic functions, infinitely divisible distributions, central limit theorems, laws of large numbers and stable laws. (Offered fall of 1968-69 and alternate years.) Graduate Staff

U.N.C. ST 232 GENERAL THEORY OF STATISTICAL DECISION 3(3-0) S
Prerequisites: U.N.C. ST 135, ST 212

Selected topics in the general theory of statistical decisions, based on the work of Abraham Wald. (Offered spring of 1968-69 and alternate years.) Graduate Staff

U.N.C. ST 235 STOCHASTIC PROCESSES 3(3-0) S
Prerequisites: U.N.C. ST 132, ST 212

Advanced theoretic course, including: separability of a process, processes with orthogonal random variables, Markov processes, martingales and processes with independent increments. (Offered spring of 1969-70 and alternate years.) Graduate Staff

U.N.C. ST 251 COMBINATORIAL PROBLEMS OF THE DESIGN
OF EXPERIMENTS 3(3-0) F
Prerequisite: U.N.C. ST 150

Application of Galois fields and two-dimensional finite geometries to the construction of complete sets of orthogonal Latin squares. Finite hyperspace geometries and balanced incomplete block designs obtainable from them. Factorial designs. Theory of confounding. Construction and analysis of symmetrical factorial designs with confounding. Construction and analysis of symmetrical fractionally replicated designs. Graduate Staff

U.N.C. ST 252 INFORMATION THEORY 3(3-0) F
Prerequisite: U.N.C. ST 132
Corequisite: U.N.C. ST 212

Transmission of information. Entropy. Simple message ensembles. Discrete sources. Transmission channels. Channel encoding and decoding. Encoding for binary symmetric channels. Encoding for discrete constant channels. Graduate Staff

U.N.C. ST 253 ERROR CORRECTING CODES

3(3-0) S

Prerequisite: U.N.C. ST 251

Linear codes and their error correction capabilities. Some important linear codes. Linear switching circuits. Cyclic codes, Bose-Chaudhuri codes. Codes for burst error correction. Recurrent codes. Codes for checking arithmetic operations.

Graduate Staff

U.N.C. ST 254 SPECIAL TOPICS IN DESIGN OF EXPERIMENTS I

3(3-0) F

Prerequisite: U.N.C. ST 150

Response surface designs. Conditions for rotatability. Construction and analysis of rotatable designs of the second and third order. Interblock analysis. General analysis of covariance. Missing plot techniques.

Graduate Staff

U.N.C. ST 255 SPECIAL TOPICS IN THE DESIGN
OF EXPERIMENTS II

3(3-0) S

Prerequisite: U.N.C. ST 251

Combinatorial properties and construction of balanced, group divisible and partially balanced designs. Impossibility proofs. Orthogonal Latin squares of nonprime power orders. Orthogonal arrays. Asymmetrical fractionally replicated designs.

Graduate Staff

U.N.C. ST 260 MULTIVARIATE ANALYSIS

3(3-0) F

Prerequisites: U.N.C. ST 135, matrices

Characterization and properties of a multivariate normal distribution, random samples from this distribution. Tests and confidence intervals related to the hypotheses of equality of two or more dispersion matrices against various types of alternatives. Multivariate analysis of variance, covariance and regression, under a linear model with fixed effects against various types of alternatives, and associated tests and confidence bounds. Association between subsets of a multivariate normal set, including several kinds of independence. Factor analysis.

Graduate Staff

U.N.C. ST 261 ADVANCED MULTIVARIATE ANALYSIS

3(3-0) S

Prerequisite: U.N.C. ST 260

Distribution problems connected with the tests and confidence intervals discussed in U.N.C. ST 260. The properties, in terms of statistical inference, of the tests and confidence intervals against different classes of alternatives. Advanced multivariate analysis of variance under a linear model with random or mixed-type effects against various kinds of alternatives. Multivariate designs for problems of MANOVA and for patterned dispersion matrices. Problems of classification. Some applications.

Graduate Staff

U.N.C. ST 262 MULTIFACTOR MULTIRESPONSE EXPERIMENTS
WITH RESPONSES NOT NECESSARILY NORMAL

3(3-0) F

Prerequisite: U.N.C. ST 150

Corequisite: U.N.C. ST 260

Unstructured and structured factors. Unstructured and structured responses based on a single or a product multinomial or hypergeometric distribution. Hypotheses against alternatives, analogous to those discussed in U.N.C. ST 260 for the multivariate normal case. Large sample tests and the associated confidence intervals. One or more structured responses based on a continuous c.d.f., and the appropriate hypotheses against alternatives in this situation. Exact and asymptotic tests.

Graduate Staff

- U.N.C. ST 263 ADVANCED MULTIFACTOR MULTIRESPONSE EXPERIMENTS WITH RESPONSES NOT NECESSARILY NORMAL 3(3-0) S
Prerequisite: U.N.C. ST 262
- Properties, in terms of statistical inference, of the tests and confidence intervals discussed in U.N.C. ST 262. Generalization of univariate or multivariate analysis of variance to the case of normal error and random effects not necessarily normal. Design and analysis of factorial experiments with one or more normal response-types, treated as a problem in structured hypothesis. Relation to the classical design and analysis of factorial experiments and to those based on the response surface approach. Graduate Staff
- U.N.C. ST 300, 301 SEMINAR IN STATISTICAL LITERATURE 1(1-0) FS
Prerequisite: U.N.C. ST 135 Graduate Staff
- U.N.C. ST 310, 311 SEMINAR IN THEORETICAL STATISTICS 3(3-0) FS
Prerequisite: U.N.C. ST 135 Graduate Staff
- U.N.C. ST 321, 322 SPECIAL PROBLEMS 3(3-0) FS
Prerequisite: Consent of instructor Graduate Staff
- U.N.C. ST 331, 332 ADVANCED RESEARCH 3(3-0) FS
Prerequisite: Consent of instructor Graduate Staff

BIOMATHEMATICS

FOR GRADUATES AND ADVANCED UNDERGRADUATES

- BMA 501 MATHEMATICAL BIOCHEMISTRY I 3(3-0) F
Prerequisites: MA 405, CH 433, BCH 551 or consent of instructor

Emphasis is placed on the kind of biochemically relevant information and insight that may be obtained through the use of physical theory and mathematics. Examination of basic principles and underlying assumptions of quantum chemistry, statistical mechanics and nonequilibrium thermodynamics as applied to biochemical systems. (Offered 1969-70 and fall of alternate years.) Mr. Gold

- BMA 502 MATHEMATICAL BIOCHEMISTRY II 3(3-0) S
Prerequisite: BMA 501

Continuation of BMA 501. Coupling of diffusion and chemical reactions. Mathematical description of enzyme control, coupled sequences of enzyme reactions, feedback loops and oscillatory reactions. Experimentally oriented topics include theory of chemical relaxation and tracer dynamics. (Offered 1969-70 and spring of alternate years.) Mr. Gold

- BMA 571 (BS 571, MA 571, ST 571) BIOMATHEMATICS I 3(3-0) F
Prerequisites: MA 301, MA 405 or equivalent

Linear time-invariant operators and their Laplace transforms, with a discussion of homogeneous and nonhomogeneous linear differential equations and their analysis in time domain and frequency domain; applications to the study of input and output in biological systems; systems of linear and nonlinear differential equations and their perturbation equations, especially with reference to the study of population dynamics and growth processes, stability of biological systems and tracer kinetics. Mr. van der Vaart

BMA 572 (BS 572, MA 572, ST 572) BIOMATHEMATICS II 3(3-0) S
 Prerequisites: BMA 571, ST 541 (MA 541) or equivalent

Continuation of topics in BMA 571. The general framework for mathematization of biological problems; deterministic and stochastic models; birth and death processes with application to physiology and population dynamics; desirable features of mathematical models in biology. Mr. van der Vaart

BMA 591 SPECIAL TOPICS 1-3 FS
 Prerequisite: Consent of instructor

Directed readings, problem sets, written and oral reports as directed by need and interest of student; new 500-level courses during the developmental phase. Graduate Staff

FOR GRADUATES ONLY

BMA 691 ADVANCED SPECIAL TOPICS 1-3 FS
 Prerequisite: Consent of instructor

Directed readings, problem sets, written and oral reports at an advanced level as dictated by need and interest of student; new 600-level courses during the developmental phase. Graduate Staff

BMA 694 SEMINAR 1(1-0) FS
 Prerequisite: Faculty recommendation

Presentation by faculty, students and visiting scientists of current and historical topics. Maximum credit: 1 in master's programs, 2 additional (3 total) in doctoral programs. Graduate Staff

BMA 699 RESEARCH 3(3-0) FS
 Prerequisite: As required

Research associated with master's thesis or doctoral dissertation. Maximum credit: 6 for master's programs, 9 additional (15 total) for doctoral programs. Graduate Staff

FOOD SCIENCE

GRADUATE FACULTY

Professor WILLIAM M. ROBERTS, *Head*

Professors: LEONARD W. AURAND, THOMAS A. BELL, THOMAS N. BLUMER, ELOISE S. COFER, JOHN L. ETHELLE, DANIEL FROMM, MAURICE W. HOOVER, IVAN D. JONES, MARVIN L. SPECK, FREDERICK G. WARREN, JAMES C. WILLIAMSON, JR.; *Associate Professors:* HARRIS B. CRAIG, VICTOR A. JONES, ALBERT E. PURCELL, HAROLD E. SWAISGOOD, FRED R. TARVER, JR., NEIL B. WEBB; *Assistant Professors:* ROBERT J. BINGHAM, WILLIAM Y. COBB, RICHARD A. COWMAN, RAGHUNATH S. DAHIYA, HENRY P. FLEMING, WILLIAM W. WALTER, JR.; *Instructor:* STANLEY E. GILLILAND

Graduate programs of study leading to the Master of Science and Doctor of Philosophy degrees are offered for students interested in the field of food

science. The professional degree, Master of Food Science, can be earned by students who do not plan further graduate study and who wish to deemphasize research in their graduate study. The programs are conducted by members of the Graduate Faculty in the Department of Food Science with corollary training in the biological and physical sciences. The student has the opportunity to develop concepts in the various areas of food science based on fundamental principles in the physical and biological sciences. Supporting course work and cooperative research are offered in areas such as chemistry, biochemistry, genetics, microbiology, physics, engineering, statistics and economics.

Areas of study and research include food chemistry, food microbiology, food engineering, and food process and product development. These areas involve all foods, including dairy products, fruits, meats, poultry products, seafood, nut-meats and vegetables. Consolidation of the study and research on foods has been made possible through the formation of the Department of Food Science.

In order to pursue graduate study in the field of food science, the student must possess adequate information in the fundamentals of the area in which he expects to specialize. The student's undergraduate education should have prepared him in mathematics, chemistry, biological and physical sciences, as well as in the humanities and language skills.

The department also participates in the Institute for Environmental Health Studies of the University of North Carolina. This is a broad interdepartmental program designed to give students training for careers in research, teaching and practice in environmental health. Students will generally enroll in the department of their specialty and select courses in other departments to obtain a broad understanding of environmental problems and their solution. This program in food science is directed toward the disciplines of the biological and physical sciences, with special orientation to food science, technology, environmental sanitation and public health.

The Department of Food Science is housed in the Food Science Building which was completed in early 1968. This building provides integrated facilities for the entire program of the department. Included are research laboratories for chemistry, engineering and microbiology; teaching laboratories and lecture halls; and pilot equipment for the processing of various foods.

FOR ADVANCED UNDERGRADUATES

FS 400 FOODS AND NUTRITION

3(3-0) S

Prerequisite: CH 220

A study of the health of an individual as related to food and the ability of his body to use food. Evaluation of normal diets and factors that promote optimal nutrition throughout life, and the application of biochemistry to utilization of foods.

FS 401 MARKET MILK AND RELATED PRODUCTS

3(2-3) F

Principles of processing, distribution and quality of fluid milk and related products.

FS 403 ICE CREAM AND RELATED FROZEN DAIRY FOODS 3(2-3) S
Prerequisite: FS 401

Choice, preparation and processing of ingredients and freezing of ice cream and other frozen desserts.

FS 404 (PO 404) POULTRY PRODUCTS 3(2-3) F
 (See Poultry Science, page 229.)

FS 410 FOOD PRODUCTS EVALUATION 3(2-3) S
Prerequisite: ST 361 or equivalent

A comprehensive study of problems encountered in new food product development with consumer acceptance. A study of the nature of sensory responses with emphasis on taste, smell and appearance (color) as related to foods; design and methodology of small and large consumer panel testing; and the application of appropriate mathematical procedures to food acceptance testing and methodology.

FOR GRADUATES AND ADVANCED UNDERGRADUATES

FS 502 FOOD CHEMISTRY 3(3-0) F
Prerequisite: CH 220 or CH 221

The basic composition, structure and properties of food, and the chemistry of changes occurring during processing and utilization of food. Interpretation and integration of widely published data in the food field with basic principles of chemistry.
 Mr. Bingham

FS 503 FOOD ANALYSIS 3(1-6) S
Prerequisites: BCH 351, CH 215, FS 502

A study of the principles, methods and techniques necessary for quantitative physical and chemical analyses of food and food products. Results of analysis will be studied and evaluated in terms of quality standards and governing regulations.
 Mr. Cobb

FS 505 (MB 505) FOOD MICROBIOLOGY 3(2-3) F
Prerequisites: MB 401, MB 402

The relationship of habitat to the occurrence of microorganisms on foods; environmental factors affecting the growth of various microorganisms in foods; microbiological action in relation to food spoilage and food manufacture; physical, chemical and biological destruction of microorganisms in foods; methods for microbiological examination of foodstuffs; and public health and sanitation bacteriology.
 Mr. Speck

FS 506 (MB 506) ADVANCED FOOD MICROBIOLOGY 3(0-9) S
Prerequisite: FS 505 or equivalent

Ecology and physiology of microorganisms important in the manufacture and deterioration of various classes of foods; the identification of representative species of such microorganisms isolated from natural environments; principles of nutrition, symbiosis and bacteriophage activity in culture maintenance for food production.
 Mr. Speck

FS 521, 522 TECHNOLOGY OF FRUIT AND VEGETABLE PRODUCTS 3(2-3) FS
Prerequisites: MB 401, MB 402

Comprehensive treatment of principles and methods of preservation of fruits and vegetables, including studies of commercial plant operations, and visits to food processing plants.
 Mr. Hoover

FS 590 FOOD SCIENCE SEMINAR

1(1-0) S

Prerequisites: Senior or graduate standing, consent of instructor

A review and discussion of scientific articles, progress reports in research and special problems of interest. Graduate Staff

FS 591 SPECIAL PROBLEMS IN FOOD SCIENCE

1-3 FS

Prerequisites: Senior or graduate standing, consent of instructor

Analysis of scientific, engineering and economic problems of current interest in foods. The scientific appraisal and solution of a selected problem. The problems are designed to provide training and experience in research.

Graduate Staff

FOR GRADUATES ONLY**FS 690 SEMINAR IN FOOD SCIENCE**

1(1-0) FS

Preparation and presentation of scientific papers, progress reports of research and special topics of interest in foods. Graduate Staff

FS 691 SPECIAL RESEARCH PROBLEMS IN FOOD SCIENCE

Credits Arranged

Directed research in a specialized phase of food science designed to provide experience in research methodology and philosophy. Graduate Staff

FS 699 RESEARCH IN FOOD SCIENCE

Credits Arranged

Original research preparatory to the thesis for the Master of Science or Doctor of Philosophy degree. Graduate Staff

SCHOOL OF FOREST RESOURCES**GRADUATE FACULTY***Professor* RICHARD J. PRESTON, *Dean*

Professors: ROY M. CARTER, CHARLES B. DAVEY, JOHN W. DUFFIELD, ERIC L. ELLWOOD, THOMAS I. HINES, JOE O. LAMMI, T. EWALD MAKI, ALFRED J. STAMM, VIVIAN T. STANNETT, BRUCE J. ZOBEL; *Adjunct Professors:* GEORGE H. HEPTING, BENJAMIN A. JAYNE, LOUIS J. METZ, THOMAS H. RIPLEY, STANLEY K. SUDDARTH; *Associate Professors:* ALDOS C. BAREFOOT, JR., WYN BROWN, ARTHUR W. COOPER, ELLIS B. COWLING, MAURICE H. FARRIER, WILLIAM L. HAFLEY, JAMES W. HARDIN, CLARENCE A. HART, ROBERT G. HITCHINGS, CHARLES S. HODGES, JR., GENE NAMKOONG, THOMAS O. PERRY, RICHARD J. THOMAS, LEROY C. SAYLOR; *Assistant Professors:* LARRY F. GRAND, GORDON A. HAMMON, CHESTER G. LANDES; *Adjunct Assistant Professors:* JEROME W. KOENIG, ELMER G. KUHLMAN, ROY W. STONECYPHER

The School of Forest Resources, through its Departments of Forestry and Wood Science and Technology, offers graduate work leading to the master's and the Doctor of Philosophy degrees. Two types of master's programs are available to the graduate student.

The professional degrees of Master of Forestry and Master of Wood Technology are offered for students interested in advanced applications of

fundamental principles to the specialized fields of forestry. The course program emphasizes professional specialization.

The degree of Master of Science is offered for the student who wishes to undertake the scholarly disciplines required in the mastery of literature and preparation of a thesis in a specialized field. The course of study for this degree provides for a comprehensive knowledge of forestry or wood science and technology and furnishes the training essential for successful research in these fields. Education is broadly based and emphasizes fundamental science. There is both a thesis and language requirement.

Students with a bachelor's degree in forestry may secure the master's degree in two academic years or less provided they have met the forestry curriculum requirements in mathematics and the biological, physical and social sciences. Candidates for the degree of Master of Forestry or Master of Science in forestry who do not hold an undergraduate degree in forestry may be required to start their programs with the summer camp.

The Doctor of Philosophy degree is available to students of high intellectual capacity who can demonstrate the ability to undertake original research and scholarly work at the highest levels.

Joint faculty appointments with other departments provide exceptional opportunities for graduate study in biometry, botany, ecology, entomology, genetics, plant pathology, soil science, wildlife science, wood and polymer chemistry, and chemical engineering. Strong programs also exist in economics, hydrology and public administration.

Students concerned with the problems of restoring and improving the quality of our environment may find appropriate graduate study based in the School of Forest Resources. Programs are available which provide for concentration in such areas as pollution control and abatement, water resources management and aesthetics.

GRADUATE PROGRAMS IN THE DEPARTMENT OF FORESTRY

Graduate programs in the general area of resources and their management are usually organized with a major in forestry and a minor in disciplines such as botany, economics, entomology, experimental statistics, horticulture, plant pathology, public administration, soil science or zoology. Alternatively, the interdisciplinary nature of resource studies may be recognized by co-major structuring of graduate programs, with co-chairmen drawn from the Department of Forestry and the appropriate cooperating department.

GRADUATE PROGRAMS IN THE DEPARTMENT OF WOOD SCIENCE AND TECHNOLOGY

Faculty members lecture and conduct research in wood and paper physics, wood and paper chemistry, wood structure and biology, wood

engineering, wood processing, wood industry econometrics, operations research, pulp and paper processing, and paper coatings.

A graduate student majoring in the department may choose to concentrate his major in either wood science, pulp and paper science or wood chemistry. He also elects a minor in complementary fields such as chemistry, textile (polymer) chemistry, biology, biochemistry, statistics, mathematics, engineering (several options), economics or operations research. A feature of the program is its flexibility and the opportunity to undertake interdisciplinary work. The department works with each student to formulate a program suited to his needs. Prior training at the undergraduate level in wood science and technology is not mandatory for several of the graduate programs, providing the student has a sound background in the natural sciences and mathematics.

FACILITIES

The School of Forest Resources is now housed in three modernly equipped buildings on the west side of the campus. A new building, to replace the facilities in Kilgore Hall and the Field House is to be ready for occupancy early in 1969. Among the unique facilities at present available in Kilgore Hall is a remote outlet to an IBM 360-75 computer of the Triangle Universities Computer Center. Facilities for forest biological research include two greenhouses, a small experimental nursery and an off-campus laboratory equipped for the study of carbon and water metabolism of tree seedlings. The experimental and production forests of the school total more than 80,000 acres. The Hofmann Forest on the coastal plain, the Goodwin Forest at the edge of the sandhills, and the Schenck, Hope Valley and Hill forests in the Piedmont provide a variety of forest types and problems in the management of timber, water, wildlife and recreational resources. The Hill and Schenck forests include natural areas, excluded from normal management operations, for the study of forest ecology.

The Brandon P. Hodges Wood Products Laboratory is one of the most completely equipped laboratories for education and research in wood science and technology. This structure houses machining, drying, gluing, finishing, preserving, testing equipment and specialized research laboratories in addition to a primary wood conversion plant. Optical and electron microscope facilities are available in addition to isotope radiation sources elsewhere on the campus.

The Reuben B. Robertson Pulp and Paper Laboratory is unique in the South and provides equipment for wood preparation, pulping, paper testing, coating and coloring, in addition to a pilot paper machine. Equipment available for wood chemistry studies also includes spectrophotometers, an ultracentrifuge and nuclear magnetic resonance apparatus.

The School of Forest Resources has exceptionally close working relations and cooperative programs of research and development with public agencies, both federal and state, and with the forest industries of the southeastern states. The U. S. Forest Service has located four scientists in the school to work jointly with other faculty in teaching and research.

FOR ADVANCED UNDERGRADUATES

FOR 403 PAPER PROCESS ANALYSIS

3(0-6) F

Manufacture of several types of papers with particular attention to stock preparation, sizing, filling and coloring. The finished products are tested physically and chemically and evaluated from the standpoint of quality and in comparison with the commercial products they are intended to duplicate.

FOR 406 FOREST LAND INVENTORY AND PLANNING

6(2-12) S

Prerequisite: FOR 531

Application of management, logging, silvicultural and utilization practices on assigned areas. Resource inventory and compilation of resulting data. Each student must make a forest survey of an individual area and submit records and a plan for management.

FOR 411, 412 PULP AND PAPER UNIT PROCESSES

3(3-0) FS

Prerequisites: PY 202 or PY 212, CHE 302, FOR 322

Principles of operation, construction and design of process equipment in the pulp and paper industry.

FOR 413 PAPER PROPERTIES AND ADDITIVES

4(1-9) F

Physical, chemical and microscopic examination of experimental and commercial papers and evaluation of the results in terms of the utility of the product tested.

FOR 422 FOREST PRODUCTS

3(3-0) F

Prerequisites: CH 220, FOR 202

The source and method of obtaining derived and manufactured forest products other than lumber.

FOR 423 LOGGING AND MILLING

3(2-3) F

Timber harvesting and transportation methods, equipment and costs; safety and supervision; manufacturing methods; log and lumber grades.

FOR 432 MERCHANDISING FOREST PRODUCTS

2(2-0) F

Principles and practices in the distribution and marketing of the products obtained from wood; organization and operation of retail, concentration and wholesale outlets.

FOR 434 WOOD OPERATIONS I

3(2-3) F

Prerequisites: FOR 301, FOR 302

Organization of manufacturing plants producing wood products including company organization, plant layout, production planning and control. Analysis of typical manufacturing operations in terms of process equipment, size and product specification. The organization and operation of wood products markets.

FOR 435 WOOD OPERATIONS II

3(2-3) S

Prerequisites: FOR 301, FOR 302

The application of the techniques of operations analysis to management decision-making in the wood products field. Choice of products to manufacture. Allocation of production resources. Development of product distribution systems.

FOR 441 DESIGN OF WOOD STRUCTURES

3(2-3) F

Prerequisite: EM 211

Strength and related properties of commercial woods; standard A.S.T.M.

strength tests; toughness; timber fastenings; design of columns; simple, laminated and box beams; trusses and arches.

FOR 444 INTRODUCTION TO QUALITY CONTROL 3(2-3) S
Prerequisite: ST 361

A study of methods used to control quality of manufactured wood products. Control charts for variables and attributes. Acceptance sampling techniques.

FOR 451 FOREST RECREATION POLICY AND MANAGEMENT 2(2-0) F

Analysis of outdoor recreation policies in the United States and their significance to forest land management; evaluation of the recreation potential of forests and other wild lands; examination of the relationships between federal, state and local government and private enterprise in providing outdoor recreation opportunities.

FOR 452 SILVICS 4(3-2) S
Prerequisites: BS 100 or BO 200, CH 103, PY 221 or PY 212, MA through calculus

Physiological ecology of the plants composing forest communities, including consideration of genotypic and phenotypic variation. Plant responses to environmental factors, including plant interactions, as a basis for techniques for manipulating forest communities and their productivity, protective and aesthetic values, or suitability as wildlife habitats.

FOR 461 PAPER CONVERTING 1(1-0) S

A survey of the principal processes by which paper and paper board are fabricated into the utilitarian products of everyday use.

FOR 462 ARTIFICIAL FORESTATION 2(1-3) S

Production collection, extraction and storage of forest tree seeds; nursery practice; field methods of planting.

FOR 463 PLANT INSPECTIONS 1(0-3) S

One-week inspection trips covering representative manufactures of pulp paper and papermaking equipment.

FOR 471 PULPING PROCESS ANALYSIS 4(1-9) F

Preparation and evaluation of the several types of wood pulp. The influence of the various pulping and bleaching variables on pulp quality are studied experimentally and these data evaluated critically.

FOR 472 RENEWABLE RESOURCE MANAGEMENT 3(3-0) F
Prerequisites: BO 200, BS 100, junior or senior standing

The concepts and problems of coordinated use and management of the renewable resources: namely soil, water, vegetation and fauna. Man as a biological factor interacting with other components of terrestrial ecological systems, particularly forests and related communities. The interrelationships of forests, water, range-land, wildlife and outdoor recreation are studied and their aesthetic and economic values considered. Resource inventory and management techniques are examined and resource and economics policies are discussed.

FOR 481 PULPING PROCESSES AND PRODUCTS 2(2-0) S
Prerequisites: CH 220, FOR 202

Wood pulp manufacturing processes and equipment; wall insulation and container board products; manufacture of roofing felts; pulp products manufacturing; resin and specialty products, lignin and wood sugar products.

FOR 482 PULP AND PAPER MILL MANAGEMENT 2(2-0) S

A survey of the economics of the pulp and paper industry is followed by a study of the work of the several departments of a paper mill organization and the functions of the executives who administer them.

FOR 491, 492 SENIOR PROBLEMS Credits Arranged
Prerequisite: For FOR 492, FOR 491

Problems selected with faculty approval in the areas of management or technology.

FOR GRADUATES AND ADVANCED UNDERGRADUATES

FOR 511 SILVICULTURE 3(3-0) F
Prerequisite: FOR 452 or BO 442

The principles and techniques applied in regulating the regeneration, species composition, growth and quality of woody vegetation; the use of planting, seeding, cutting, fire and herbicides in regulation of vegetation. The application of silvicultural techniques in selected regions of the United States. Mr. Duffield

FOR 512 FOREST ECONOMICS 3(3-0) S
Prerequisites: EC 201, FOR 372

Economics and social value of forests; supply of and demands for forest products; land use; forestry as a private and a public enterprise; economics of the forest industries. Mr. Lammi

FOR 513 TROPICAL WOODS 2(1-3) S
Prerequisites: FOR 203, FOR 301

Structure, identification, properties, characteristics and use of tropical woods, especially those used in plywood and furniture. Mr. Barefoot

FOR 521, 522 CHEMISTRY OF WOOD AND WOOD PRODUCTS 3(2-3) FS
Prerequisites: CH 215, CH 426, FOR 202, PY 212

Fundamental chemistry and physics of wood and wood components; pulping principles; electrical and thermal properties. Mr. Stamm

FOR 531 FOREST MANAGEMENT 3(2-3) F
Prerequisite: FOR 372
Corequisite: FOR 511

Management of timber lands for economic returns; the normal forest taken as the ideal; the application of regulation methods to the forest. Graduate Staff

FOR 533 ADVANCED WOOD STRUCTURE AND IDENTIFICATION 2(1-3) F
Prerequisite: FOR 202

Advanced microscopic identification of the commercial woods of the United States and some tropical woods; microscopic anatomical features and laboratory techniques. Mr. Barefoot

FOR 553 FOREST PHOTOGRAMMETRY 3(2-1) S
Prerequisite: FOR 472 or FOR 531 or consent of instructor

The stereoscopic use of aerial photographs for land use and vegetation interpretation will be emphasized. Some developments in remote sensing of environment will be reviewed, including infrared light, thermal infrared, microwave and radar imagery. Laboratory exercises include identification of plant cover and culture, measurement of elevations and heights of objects, determination of tree cover densities and volumes, road location and rudimentary mapping. Mr. Lammi

FOR 571 ADVANCED FOREST MENSURATION 3(2-2) S
Prerequisites: FOR 372, ST 311

Study of cyclical variation in growth of individual trees and stands; analysis of stand structures in even-aged versus all-age stands; general concepts of growing stock levels on yields; evaluation of growth prediction methods. Mr. Hafley

FOR 572 CONSERVATION POLICY ISSUES 3(3-0) F
Prerequisite: FOR 472 or ZO 221 or consent of instructor

Analysis of the attitudes of selected private groups and public agencies toward multiple resource development. Special attention is directed to the trends in development of forest resource policies, timber management objectives, private industry activity in forestry development, recreation and multiple use, education, research, watersheds, governmental activity, interaction in international forestry affairs and the role of professional foresters and related specialists in multiple use resource management. Mr. Lammi

FOR 591 FORESTRY PROBLEMS Credits Arranged
Prerequisite: Senior or graduate standing

Assigned or selected problems in the fields of silviculture, logging, lumber manufacturing, wood science, pulp and paper science, wood chemistry or forest management. Graduate Staff

FOR 599 METHODS OF RESEARCH IN FORESTRY Credits Arranged
Prerequisite: Senior or graduate standing

Research procedures, problem outlines, presentation of results; consideration of selected studies by forest research organizations; sample plot technique. Graduate Staff

FOR GRADUATES ONLY

FOR 603 TECHNOLOGY OF WOOD ADHESIVES 3(3-0) F or S
Prerequisites: CH 425, CH 426, FOR 433

The fundamentals of adhesives as applied to wood-to-wood and wood-to-metal bonding. Technology of adhesives. Preparation and use of organic adhesives. Testing of adhesives and evaluation of quality of adhesives and bonded joints. Mr. Hart

FOR 604 TIMBER PHYSICS 3(3-0) F or S
Prerequisite: FOR 441

Density, specific gravity and moisture content variation affecting physical properties; physics of drying at high and low temperatures; thermal, sound, light and electrical properties of wood. Messrs. Ellwood, Hart

FOR 605 DESIGN AND CONTROL OF WOOD PROCESSES 3(3-0) F or S
Prerequisite: FOR 604

Design and operational control of equipment for processing wood. Mr. Ellwood

FOR 606 WOOD PROCESS ANALYSIS 3(3-0) F
Prerequisites: FOR 512, FOR 604

Analysis of wood process through the solution of comprehensive problems involving the physics of temperature and moisture relations. Mr. Ellwood

FOR 607 ADVANCED QUALITY CONTROL 3(3-0) S
Prerequisites: FOR 606, ST 515

Advanced statistical quality control as applied to wood processing. Mr. Hart

FOR 611 (GN 611) FOREST GENETICS

3(3-0) F or S

Prerequisites: GN 411, consent of instructor

Application of genetic principles to silviculture, management and pulp utilization. Emphasis is on variations in wild populations, on the bases for selection and desirable qualities and on fundamentals of controlled breeding.

Messrs. Saylor, Zobel

FOR 612 (GN 612) ADVANCED TOPICS IN QUANTITATIVE GENETICS

3(3-0) F

Prerequisites: GN 611, GN 626 or GN 603 or consent of instructor

Advanced topics in statistics and population genetics pertinent to current research problems in genetics with special applications to forestry. Basic statistical and genetic theory is to be reviewed as bases for intensive study of selection theory and experimental and mating design evaluation. The genetics of natural populations are also to be studied for evolutionary interest as well as for their implications to breeding theory. The format shall be part lecture and part student and faculty discussion of current research.

Mr. Nankoong

FOR 613 SPECIAL TOPICS IN SILVICULTURE

3(2-1) F

Prerequisite: FOR 511 or consent of instructor

Critical examination of selected topics, with special emphasis on concepts and phenomena which distinguish forests from other biotic communities and silviculture from other fields of applied biology.

Mr. Duffield

FOR 691 GRADUATE SEMINAR

1(1-0) F or S

Prerequisite: Graduate standing in forestry or closely allied fields

Presentation and discussion of progress reports on research, special problems and outstanding publications in forestry and related fields.

Graduate Staff

FOR 692 ADVANCED FOREST MANAGEMENT PROBLEMS

Credits Arranged

Prerequisite: Graduate standing

Directed studies in forest management.

Graduate Staff

FOR 693 ADVANCED WOOD TECHNOLOGY PROBLEMS

Credits Arranged

Prerequisite: Graduate standing

Selected problems in the field of wood technology.

Graduate Staff

FOR 699 PROBLEMS IN RESEARCH

Credits Arranged

Prerequisite: Graduate standing

Specific forestry problems that will furnish material for a thesis.

Graduate Staff

GENETICS**GRADUATE FACULTY***Professor THURSTON J. MANN, Head*

Professors: CAREY H. BOSTIAN, DANIEL S. GROSCH, WARREN D. HANSON, DALE F. MATZINGER, ROBERT H. MOLL, HAROLD F. ROBINSON, BENJAMIN W. SMITH, STANLEY G. STEPHENS; *Associate Professors:* LAWRENCE G. BURK, CHARLES S. LEVINGS, III, LAWRENCE E. METTLER, GENE NAMKOONG, LEROY C. SAYLOR, ANASTASIOS C. TRIANTAPHYLLOU; *Assistant Professors:* WESLEY E. KLOOS, HENRY E. SCHAEFFER, ROBERT H. SCHAEUBLE, WILFRED M. SCHUTZ, CHARLES W. STUBER

ASSOCIATE MEMBERS OF THE DEPARTMENT

Professors: JAY L. APPLE, ERNEST O. BEAL, CHARLES A. BRIM, FRED D. COCHRAN, COLUMBUS C. COCKERHAM, JOHN W. DUFFIELD, DONALD A. EMERY, DAN U. GERSTEL, EDWARD W. GLAZENER, WALTON C. GREGORY, PAUL H. HARVEY, FRANK L. HAYNES, JR., TEDDY T. HERBERT, GUY L. JONES, KENNETH R. KELLER, JAMES E. LEGATES, PHILLIP A. MILLER, LYLE L. PHILLIPS, DANIEL T. POPE, NATHANIEL T. POWELL, HAMILTON A. STEWART, DONALD L. THOMPSON, DAVID H. TIMOTHY, NASH N. WINSTEAD, BRUCE J. ZOBEL; *Associate Professors:* FRANK B. ARMSTRONG, WILLIAM L. BLOW, WILL A. COPE, EMMETT U. DILLARD, EUGENE J. EISEN, GENE J. GALLETTA, GEORGE R. GWYNN, JAMES W. HARDIN, JOSHUA A. LEE, CHARLES F. MURPHY, THOMAS O. PERRY, JOHN O. RAWLINGS, ODIS W. ROBINSON; *Assistant Professors:* BURTON J. LANG, EARL A. WERNSMAN

Graduate study under the direction of the genetics faculty may enable the student to qualify for the Master of Science or the Doctor of Philosophy degrees. A candidate for the master's degree must acquire a thorough understanding of genetics and its relation to other biological disciplines and must present a thesis based upon his own research. In addition to a comprehensive knowledge of his field, a candidate for the doctorate must demonstrate his capacity for independent investigation and scholarship in genetics.

At North Carolina State University there are no sharp divisions along departmental lines between theoretical and applied aspects of genetics research. The members and associate members of the genetics faculty are located in different departments of the School of Agriculture and Life Sciences, the School of Forest Resources and the School of Physical Sciences and Applied Mathematics. They are studying an extremely wide range of genetic problems and are utilizing not only the "classic" laboratory material (*Drosophila*, *Habrobracon*, maize and mice) but also farm animals and agricultural and horticultural plants of the region. A student has, therefore, a wide choice of research problems in any of the following fields: cytology and cytogenetics, microbial and biochemical genetics, physiological and developmental genetics, evolution and speciation, quantitative and population genetics, and the application of genetics to breeding methodology.

The offices and laboratories of the department are located in Gardner Hall with greenhouse facilities adjacent to the building. A genetics garden for use in intensive research with plants and teaching functions is located three miles from the departmental offices. The departmental staff and the associate faculty members in animal science, biochemistry, botany, crop science, horticultural science, microbiology, poultry science, plant pathology, experimental statistics and forest management are most fortunate in being able to draw upon the extensive facilities of the North Carolina Agricultural Experiment Station.

FOR ADVANCED UNDERGRADUATES

GN 411 THE PRINCIPLES OF GENETICS
Prerequisite: BS 100

3(3-0) FS

An introductory course. The physical and chemical basis of inheritance; genes

as functional and structural units of heredity and development; qualitative and quantitative aspects of genetic variation.

GN 412 ELEMENTARY GENETICS LABORATORY

1(0-2) FS

Prerequisite or corequisite: GN 411

Experiments and demonstrations to provide an opportunity to gain practical experience in crossing and classifying a variety of genetic materials including two generations of *Drosophila*.

FOR GRADUATES AND ADVANCED UNDERGRADUATES

**GN 503 (ANS 503) GENETIC IMPROVEMENT OF LIVESTOCK
AND POULTRY**

3(2-3) F

(See Animal Science, page 63.)

GN 504 HUMAN GENETICS

3(3-0) S

Prerequisite: GN 301 or GN 411, or equivalent

The basic principles needed for an understanding of the genetics of man will be presented. Current knowledge and important areas of research in human genetics will be surveyed. This course will not be accepted in the core requirements for an advanced degree in genetics but is intended to serve the needs of advanced undergraduates and graduates other than majors in genetics.

Messrs. Bostian, Schaffer

GN 505 GENETICS I

4(3-2) F

Prerequisite: GN 411 or equivalent

Part I of a course sequence designed to serve as a foundation for graduate programs in genetics. As such, a balanced and comprehensive survey of each of the major fields of genetics must be presented in integrated form. Concepts based upon family analysis and a study of individual organisms will be presented here. Coverage will include general plant and animal genetics, biochemical and microbial genetics, and physiological and developmental genetics.

Mr. Grosch, Graduate Staff

GN 506 GENETICS II

4(3-2) S

Prerequisite: GN 505 or consent of instructor

This course represents the second portion of a two-semester sequence in general genetics, which is presented at the intermediate level and directed primarily to beginning graduate students. Emphasis is placed on the basic principles and modern concepts of cytogenetics, population genetics and quantitative genetics. These subjects are integrated with those of the first semester course as much as possible, with the primary synthesis being directed toward the dynamic aspects of evolutionary theory, including both intra- and inter-populational phenomena.

Mr. Mettler, Graduate Staff

GN 513 CYTOGENETICS

4(3-2) F

Prerequisite: GN 506 or consent of instructor

Classical and contemporary problems of chromosome structure, behavior and transmission. Euchromatin and heterochromatin. Recombination. Structural and numerical aberrations of chromosomes and the effects upon breeding systems of plants and animals. Interspecific hybridization. Polyploidy.

Messrs. Galletta, Gerstel

GN 520 (PO 520) POULTRY BREEDING 3(2-2) F
(See Poultry Science, page 229.)

GN 532 (ZO 532) BIOLOGICAL EFFECTS OF RADIATIONS 3(3-0) S
Prerequisite: BS 100 or GN 301 or consent of instructor

Qualitative and quantitative effects of radiations (other than the visible spectrum) on biological systems, to include both morphological and physiological aspects in a consideration of genetics, cytology, histology and morphogenesis.

Mr. Grosch

GN 540 (ZO 540) EVOLUTION 3(3-0) F
Prerequisite: GN 411 or consent of instructor

The facts and theories of evolution in plants and animals. The causes and consequences of organic diversity.

Mr. Smith

GN 541 (CS 541, HS 541) PLANT BREEDING METHODS 3(3-0) F
(See Crop Science, page 95.)

GN 542 (CS 542, HS 542) PLANT BREEDING FIELD PROCEDURES 2(0-4) Sum.
(See Crop Science, page 95.)

GN 545 (CS 545) ORIGIN AND EVOLUTION OF CULTIVATED PLANTS 2(2-0) S
(See Crop Science, page 95.)

GN 550 (ZO 550) EXPERIMENTAL EVOLUTION 3(3-0) F
Prerequisite: GN 506 or consent of instructor

Experimental evolution deals primarily with micro-evolutionary processes examined at the inter- and intra-specific population level. A review of the results from experimental population studies and analyses of natural populations concerning variation patterns and adaptation, natural selection, polymorphism, introgression, population breeding structure, isolating mechanism, etc., is made and interpreted in relation to Neo-Darwinian concepts of the origin of species.

Mr. Mettler

GN 561 (BCH 561, MB 561) BIOCHEMICAL AND MICROBIAL GENETICS 3(3-0) F
Prerequisite: GN 505 or consent of instructor

The course will include the development of the fields of biochemical and microbial genetics and will emphasize both the techniques and concepts utilized in current research.

Mr. Armstrong

FOR GRADUATES ONLY

GN 603 (ANS 603) POPULATION GENETICS IN ANIMAL IMPROVEMENT 3(3-0) F
(See Animal Science, page 63.)

GN 611 (FOR 611) FOREST GENETICS 3(3-0) S
(See Forest Resources, page 148.)

GN 612 (FOR 612) ADVANCED TOPICS IN QUANTITATIVE GENETICS 3(3-0) F
(See Forest Resources, page 148.)

GN 613 (CS 613) PLANT BREEDING THEORY 3(3-0) S
(See Crop Science, page 96.)

GN 626 (ST 626) STATISTICAL CONCEPTS IN GENETICS 3(3-0) S
(See Statistics, page 133.)

GN 631 MATHEMATICAL GENETICS 3(3-0) F
Prerequisites: GN 506, ST 511, or consent of instructor

History of mathematical biology, role of mathematical concepts in the development of genetic science, theory of genetic recombination, dynamics of genetic population. (Offered in 1967-68 and alternate years.) Mr. Hanson

GN 633 PHYSIOLOGICAL GENETICS 3(3-0) S
Prerequisite: GN 505 or equivalent

Recent advances in physiological genetics. Attention will be directed to literature on the nature and action of genes, and to the interaction of heredity and environment in the expression of the characteristics of higher organisms.

Mr. Grosch

GN 641 COLLOQUIUM IN GENETICS 2(2-0) FS
Prerequisites: Graduate standing, consent of instructor

Informal group discussion of prepared topics assigned by the instructor.

Graduate Staff

GN 691 SEMINAR 1(1-0) FS
Prerequisite: Graduate standing

GN 695 SPECIAL PROBLEMS IN GENETICS 1-3 FS
Prerequisites: Advanced graduate standing, consent of instructor

Special topics designed for additional experience and research training.

Graduate Staff

GN 699 RESEARCH Credits Arranged
Prerequisites: Graduate standing, consent of advisor

Original research related to the student's thesis problem. A maximum of six hours for the master's degree, by arrangement for the doctorate.

Graduate Staff

GEOSCIENCES

GRADUATE FACULTY

Professor CARLTON J. LEITH, *Acting Head*

Professors: HENRY S. BROWN, JOHN M. PARKER, III; *Associate Professor:* CHARLES W. WELBY

Graduate programs in geology are available leading to the Master of Science degree. Candidates for admission should hold a bachelor's degree in geology or a satisfactory equivalent, preferably with a strong background in physics, chemistry and mathematics. The graduate program consists of a minimum of 30 semester hours credit, of which six may be granted for research, a research thesis and reading competence in an appropriate foreign language.

Financial aid is available through laboratory teaching assistantships, assistantships on current research projects conducted by the staff and part-time employment by a unit of the General Hydrology division of the U. S. Geological Survey. Industrial concerns provide part-time geologic employment from time to time. Small grants from the state commonly help with thesis expenses.

The graduate programs in geology are directed to the advanced training of qualified students interested in the scientific aspects and economic applications of the geosciences. Occupational opportunities include the location and evaluation of mineral deposits, the provision of satisfactory water supplies, the disposal of fluid and solid wastes, and the assessment of geologic conditions affecting conservation and civil engineering projects. Many professional problems in geology today require more specialized and quantitative methods than can be included in an undergraduate curriculum. Students with advanced training find ready employment with petroleum, mining and construction companies, various state and federal government agencies, and educational and research institutions.

A great variety of interesting research problems having both field and laboratory aspects is to be found within a radius of some 50 miles of Raleigh. Facilities are available for research in mineralogy, petrology, hydrogeology, economic geology, mineral beneficiation and engineering geology. Related minors may include study in water resources, oceanology, soil science, statistics, civil engineering or other appropriate fields. Excellent collections of geological literature are available in the Research Triangle area. Consultation with geologists of the federal and state agencies in Raleigh, as well as with the staffs of the neighboring universities, is encouraged.

FOR ADVANCED UNDERGRADUATES

GY 415 MINERAL EXPLORATION AND EVALUATION

3(2-3) S

Prerequisites: GY 440, GY 452

Application of the principles of geology, geophysics and geochemistry to the discovery and evaluation of mineral deposits. Design of mineral exploration and development programs based on knowledge of the unique thermodynamic, geochemical and tectonic features that control mineral formation and concentrations in well-known mining districts, especially those yielding ferrous, base and precious metals. Review of economic and technological factors governing the value of mineral deposits.

GY 440 ENDOGENIC MATERIALS AND PROCESSES

4(3-3) S

Prerequisites: GY 120 or GY 220, GY 331

Minerals, rocks and mineral deposits that are formed at high temperatures and pressures by crystallization or solidification of molten magma, or by solid-state recrystallization of older rocks. Application of principles of thermodynamics and of phase-rule chemistry, and the results of modern high pressure-temperature laboratory research on the stability fields of crystalline phases, to an understanding of igneous and metamorphic rocks. Identification, classification, occurrence, origin and economic value of the principal igneous and metamorphic rocks.

GY 452 EXOGENIC MATERIALS AND PROCESSES

4(3-3) F

Prerequisites: GY 120 or GY 220, GY 331

Identification, classification, geologic occurrence, origin and economic value of minerals, rocks and mineral deposits formed by physical, chemical and biological processes at low temperatures and pressures at and near the earth's surface. Hydrodynamics of sediment transport and deposition, settling velocities and size sorting, chemical and biochemical precipitation from aqueous solutions, principles of division of stratified terraines into natural units, correlation of strata, identification of depositional environments and facies analysis.

GY 461 ENGINEERING GEOLOGY**3(3-0) F****Prerequisite:** GY 120 or GY 220

The application of geologic principles to engineering practice; analysis of geological factors and processes affecting specific engineering projects.

GY 462 GEOLOGICAL SURVEYING**3(1-5) S****Prerequisite:** GY 120

Methods of field observation and use of geologic surveying instruments in surface and underground work; representation of geologic features by maps, sections and diagrams. Laboratory hours include field work.

GY 465 GEOLOGICAL FIELD PROCEDURE**6 Sum.****Prerequisite:** GY 351 or special consent

A six-week summer field course. Practical field procedures and instruments commonly used to procure geologic data for evaluating mineral deposits, solving engineering problems involving earth materials and drawing scientific conclusions. Observation of geologic phenomena in their natural setting. Large- and intermediate-scale geologic mapping of surface features and large-scale mapping underground in mine workings.

GY 472 ELEMENTS OF MINING ENGINEERING**3(2-3) F****Prerequisites:** GY 120 or GY 220, junior standing in geology

Introduction to mining; surface and underground methods of development and production; explosives, drilling and blasting; ore loading, transport and hoisting; drainage and ventilation; mine surveying and sampling; fire assaying; mining law, organization, administration and safety. Laboratory hours include field inspections.

GY 486 WEATHER AND CLIMATE**2(2-0) F****Prerequisites:** MA 102 or MA 112, PY 211-212 or PY 221

A discussion of basic principles of meteorology and climatology. Topics discussed include the atmosphere, radiation, moisture, pressure and wind, atmospheric equilibrium, air masses and fronts. Macro- and micro-climate and the climate of North Carolina are also covered.

GY 487 (CE 487, OC 487) PHYSICAL OCEANOGRAPHY**3(3-0) S****Prerequisites:** MA 202, PY 212

An introduction, on an advanced level, to the principles of physical oceanography. Subjects to be covered are: history of physical oceanography; the geological and astronomical background for the field; tides and waves; fluid mechanics; characteristics of sea water; advective and convective processes; current measurements; laboratory models; and specific problems in physical oceanography.

GY 491, 492 SEMINAR ON SELECTED GEOLOGIC TOPICS 1-3 FS

Reports and discussion of geological topics of current interest, with attention to methodology, bibliography and research techniques.

FOR GRADUATES AND ADVANCED UNDERGRADUATES**GY 522 PETROLEUM GEOLOGY 3(3-0) S**

Prerequisite: GY 452

Properties, origin and modes of occurrence of petroleum and natural gas. Geologic and economic features of the principal oil and gas fields, mainly in the United States. Mr. Leith

GY 532 ORE MICROSCOPY 3(0-6) S

Prerequisite: GY 331

The theory and technique of microscopic investigation of opaque ore minerals, ores and mill products produced by beneficiation of ores. Studies of compositions and textures of materials in polished surfaces are based on observations of optical and physical properties, etch reactions and microchemical tests. Mr. Brown

GY 542 MICROSCOPIC PETROGRAPHY 3(1-4) S

Prerequisites: GY 331, GY 440

Systematic study by microscopic techniques of the constitution and origin of consolidated rocks. Mr. Parker

GY 552 EXPLORATORY GEOPHYSICS 3(2-3) S

Prerequisites: GY 351, PY 208 or PY 212

Fundamental principles underlying all geophysical methods; procedure and instruments involved in gravitational, magnetic, seismic, electrical and other methods of studying geological structures and conditions. Spontaneous potential, resistivity, radioactivity, temperature and other geophysical logging methods. Study of applications and interpretations of results. Mr. Leith

GY 563 APPLIED SEDIMENTOLOGY 3(3-0) S

Prerequisite: GY 452

Advanced treatment of the geological aspects of erosion and sediment transport and deposition, especially as related to engineering works, and to land and water utilization. Analysis of physical, mineralogical and some chemical properties of sediments and sedimentary rocks; interpretation of these properties in terms of depositional basins and environments. Mr. Leith

GY 565 HYDROGEOLOGY 3(3-0) F

Prerequisite: GY 452

Occurrence and sources of surface and subsurface water. Relationship of surface water to subsurface water. Rock properties affecting infiltration, movement, lateral and vertical distribution and quality of ground water. Determination of permeability, capacity, specific yield and other hydraulic characteristics of aquifers. Legal aspects of water supplies. Mr. Welby

GY 567 GEOCHEMISTRY 3(3-0) F

Prerequisite: CH 231 or CH 433

The quantitative distribution of elements in the earth's crust, the hydrosphere and the atmosphere. Application of the laws of chemical equilibrium and re-

sultant chemical reactions to natural earth systems. Geochemical applications of Eh-pH diagrams. Geochemical cycles. Isotope geochemistry. Mr. Brown

GY 571, 572 MINING AND MINERAL DRESSING 3(2-3) FS
Prerequisite: GY 472

Principles of the mineral industry; mining laws, prospecting, sampling, development, drilling, blasting, handling, ventilation and safety; administration, surveying, assaying; preparation, beneficiation and marketing. Graduate Staff

GY 581 GEOMORPHOLOGY 3(3-0) F
Prerequisite: GY 452

A systematic study of land forms and their relations to processes and stages of development and adjustment to underlying structure. Lectures, map interpretations and field trips. Mr. Welby

GY 584 (OC 584) MARINE GEOLOGY 3(3-0) S
Prerequisite: GY 452 or GY 120 plus appropriate background

Morphology, structure and origin of ocean basins with their diverse features and their relations to the continents. Physical and chemical properties of the oceans, sedimentation in the marine environment, and near-shore features. The economic potential of mineral resources derived from oceanic areas. Mr. Welby

GY 593 ADVANCED TOPICS IN GEOLOGY 1-6 FS
Prerequisite: Consent of staff

Special study of some advanced phases of geology. Graduate Staff

FOR GRADUATES ONLY

GY 611, 612 ADVANCED ECONOMIC GEOLOGY 3(3-0) FS
Prerequisites: GY 440, GY 452

Detailed study of the origin and occurrence of specific mineral deposits. Mr. Brown

GY 695 SEMINAR 1(1-0) FS
Prerequisite: Graduate standing

Scientific articles, progress reports and special problems of interest to geologists and geological and mining engineers discussed. Graduate Staff

GY 699 GEOLOGICAL RESEARCH Credits Arranged
Prerequisite: Consent of instructor

Lectures, reading assignments and reports; special work in geology to meet the needs and interests of the students. Thesis problem. Graduate Staff

GUIDANCE AND PERSONNEL SERVICES

GRADUATE FACULTY

Professor WILLIAM E. HOPKE, *Head*

Professors: ROY N. ANDERSON, CHARLES G. MOREHEAD

The department offers work leading to the Master of Science, Master of Education and Doctor of Education degrees with a major in the field of

guidance and personnel services (or counselor education). Each of these degrees is designed to prepare individuals for guidance and personnel positions at various levels in elementary and secondary schools, junior and community colleges, trade and technical schools and institutes, institutions of higher education, agencies (such as employment and rehabilitation offices), as well as guidance and personnel work in business, industry and government. The student may specialize in one of several areas depending upon his career goals.

It is desirable for an applicant to have had undergraduate or graduate course work in economics, education, psychology, sociology or social work. Students accepted into the department are those who anticipate devoting full or part-time to guidance and personnel work. Teachers, administrators and others who wish to increase their knowledge of guidance and personnel work may enroll for courses as a graduate minor or for certification renewal. Previous academic achievement, personal characteristics, emotional maturity and educational philosophy, as well as vocational goals are considered in admitting a candidate to the department.

The master's and doctoral programs include a core of guidance and personnel courses to be selected according to the student's vocational goals. Students may select their minor from the following areas: anthropology, economics, education, psychology and sociology. A master's student may select a program which meets the requirements for the Counselor's Certificate issued by the North Carolina State Department of Public Instruction as well as counselor certification in many other states.

The department also provides service courses in guidance and personnel for undergraduate students in the School of Education.

A limited number of graduate assistantships are available annually in the School of Education and through the Division of Student Affairs.

FOR GRADUATES AND ADVANCED UNDERGRADUATES

ED 520 PERSONNEL AND GUIDANCE SERVICES 3(3-0) FS

Prerequisite: Six hours of education or psychology

An introduction to the philosophies, theories, principles and practices of personnel and guidance services; the relationship of personnel services with the purposes and objectives of the school and the curriculum.

Graduate Staff

ED 524 OCCUPATIONAL INFORMATION 3(3-0) S

Prerequisites: Six hours of education or psychology, ED 520 or equivalent

This course is intended to give teachers, counselors, placement workers and personnel workers in business and industry an understanding of how to collect, classify, evaluate and use occupational and educational information. This will include a study of the world of work, sources of occupational information, establishing an educational-occupational information library, using educational, occupational and social information, and sociological and psychological factors influencing career planning.

Graduate Staff

ED 530 GROUP GUIDANCE 3(3-0) F

Prerequisites: Six hours of education or psychology, ED 520 or equivalent

This course is designed to help teachers, counselors, administrators and others who work with groups, or who are responsible for group guidance activities, to

understand the theory and principles of effective group work, to develop skill in using specific guidance techniques, and to plan and organize group activities in the secondary school and other institutions. Graduate Staff

**ED 533 ORGANIZATION AND ADMINISTRATION OF
GUIDANCE SERVICES**

3(3-0) S

Prerequisites: Graduate standing, ED 520 or equivalent

This course is designed for school guidance counselors, prospective counselors, personnel and guidance directors, and school administrators. The philosophy and scope of guidance and personnel services; the functions and responsibilities of personnel involved; basic principles and current practices in planning, developing, operating, and supervising guidance and personnel services will be studied. Administrative relationships, utilization of school staff, interrelationships of guidance services with instruction and evaluation of guidance services will be considered. Graduate Staff

ED 540 INDIVIDUAL AND GROUP APPRAISAL I

3(3-0) F

Prerequisites: ED 520, PSY 535, or equivalent

Use of group tests of intelligence, interest and achievement in educational and career planning and in placement. Theories of intelligence and interest will be followed by laboratory in evaluating, administering and interpreting widely used group tests of intelligence, interest and achievement. Emphasis is on the use of group tests in group guidance. Graduate Staff

ED 590 INDIVIDUAL PROBLEMS IN GUIDANCE

Maximum 6 FS

Prerequisite: Six hours graduate work in department or equivalent

Intended for individual or group studies of one or more of the major problems in guidance and personnel work. Problems will be selected to meet the interests of individuals. The workshop procedure will be used whereby special projects, reports and research will be developed by individuals and by groups. Graduate Staff

FOR GRADUATES ONLY

ED 631 EDUCATIONAL AND VOCATIONAL GUIDANCE

3(3-0) F

Prerequisite: Nine hours from following fields—economics, education, psychology or sociology

The development of a philosophy and point of view of vocational guidance from an interdisciplinary approach—economics, education, psychology and sociology. The course aims to provide basic understandings for counselors in educational settings, employment offices, personnel workers, rehabilitation settings and social workers, who are aiding individuals with vocational decision-making and vocational adjustment problems. The course will cover the basic functions performed in vocational and educational guidance. Graduate Staff

ED 633 TECHNIQUES OF COUNSELING

3(3-0) S

Prerequisite: Nine hours from following fields—economics, education, psychology or sociology

This course is designed to aid the personnel worker in the secondary school, college, employment office or social agency to develop an understanding and to develop skill in counseling techniques; philosophies, theories, principles and practices of counseling will be considered. Students will become acquainted with

counseling techniques through lectures, demonstrations, case histories and tape recordings. Attention will be given to both diagnosis and treatment.

Graduate Staff

ED 640 INDIVIDUAL AND GROUP APPRAISAL II

3(3-0) S

Prerequisites: ED 520, ED 540, PSY 535, or equivalent

Use of individual tests in the individual counseling of normal students. Theories of aptitudes and personality will be followed by laboratory in evaluating, administering and interpreting individual tests of intelligence, special aptitudes and personality.

Graduate Staff

ED 641 LABORATORY AND PRACTICUM EXPERIENCES IN COUNSELING

2-6 FS

Prerequisite: Advanced graduate standing

A practicum course in which the student participates in actual counseling experience under supervision in a school, college, social service agency, employment office and business or industrial establishment. The student may observe and participate in some personnel and guidance services and may study the organization and administration of the program.

Graduate Staff

HISTORY

GRADUATE FACULTY

Professor RALPH W. GREENLAW, *Head*

Professors: BURTON F. BEERS, MARVIN L. BROWN, JR., DORIS E. KING, STUART NOBLIN; *Associate Professor:* MURRAY S. DOWNS; *Assistant Professors:* JOHN M. RIDDLE, MARY E. WHEELER

The history department offers a program leading to the Master of Arts degree in history. Although there are no specific requirements for admission to the program beyond the bachelor's degree, preference will be given to candidates who offer at least 18 hours in history and a total of 30 hours in the social sciences.

Normally a degree candidate will concentrate his work in either European or American history with the required total of 30 hours being made up of nine to 12 hours of course work at the 500 level or above; six hours of research seminar (600 level); up to six hours of research and preparation of thesis (600 level); and six to nine hours of course work in a field related to the candidate's area of concentration (500 or 600 level). Under special circumstances a candidate may be permitted to include a 400-level course in his program if it has particular relevance to his program objectives.

Candidates concentrating in American history have the advantage of the excellent source materials available nearby at the State Department of History and Archives. It should be noted that a candidate's degree program can include a two-semester sequence in the history and administration of archives, a field in which there is considerable demand for well-trained people at this time. For master's candidates interested in teaching in the public schools, the education and other courses required for the state certificate are available but inclusion of these will in most cases extend the time needed for the degree to three or four semesters.

It is expected that fellowships may be available by the fall of 1968 and

inquiry concerning these should be addressed to the history department office, 109 Harrelson Hall.

FOR ADVANCED UNDERGRADUATES

HI 401 HISTORY OF RUSSIA TO 1881 3(3-0) F
Prerequisite: Three hours of history or consent of department

This course surveys the history of Russia from its origins through the great reforms (mid-nineteenth century) with emphasis on the political, religious and cultural trends that underlie the development of the Russian state and society during this period.

HI 402 HISTORY OF RUSSIA SINCE 1881 3(3-0) S
Prerequisite: Three hours of history

This course surveys the history of Russia and the Soviet Union from the great reforms of the nineteenth century to modern times, with emphasis on the political, religious and cultural trends that underlie the development of the Russian state and society and the position of the U.S.S.R. in the world today.

HI 407 FRANCE SINCE THE REVOLUTION 3(3-0) F
Prerequisite: Three hours of history or consent of department

An examination of the major trends in French history since the downfall of Napoleon I. Cultural, economic, social and intellectual trends are stressed as well as the political. The ways in which France has been a seedbed for new movements in Europe are particularly noted.

HI 413 UNITED STATES FOREIGN RELATIONS SINCE 1898 3(3-0) F
Prerequisite: Three hours of history or consent of department

An examination of the origins of American foreign policy and the conduct of diplomacy in the era since the United States became a world power.

HI 422 HISTORY OF SCIENCE 3(3-0) FS
Prerequisite: Three hours of history or consent of department

A study of the evolution of science from antiquity to the present with particular attention given to the impact of scientific thought upon selected aspects of western civilization. The course provides a broad perspective of scientific progress and shows the interrelationship of science and major historical developments.

HI 427 EUROPEAN INTELLECTUAL HISTORY SINCE 1800 3(3-0) F
Prerequisite: Three hours of history or consent of department

Covering the period since the French Revolution this course examines major trends in European thought influencing the course of history. Special attention is given to the development of the social sciences. The growth of a distinct intellectual class and the role of its ideas in European political and social life is emphasized.

HI 462 (ED 462) HISTORY OF EDUCATION 3(3-0) S
Prerequisite: Three hours of history or consent of department

The course traces the development of educational institutions and practices and analyzes the ideas and influence of educational innovators and critics. Ap-

proximately equal time is given to each of the following areas: the Greeks to the Reformation, Modern Europe and the United States.

HI 470 (EC 470) EVOLUTION OF THE AMERICAN ECONOMY 3(3-0) S
(See Economics, page 100.)

FOR GRADUATES AND ADVANCED UNDERGRADUATES

HI 505 THE ROMAN REVOLUTION, 133 B.C.-27 B.C. 3(3-0) F
Prerequisite: Six hours of European history above the introductory level or consent of department

An analysis of the economic, cultural and political factors which caused a breakdown of the Roman republican constitution. Mr. Riddle

HI 506 HISTORY OF THE ROMAN EMPIRE, 27 B.C.-180 A.D. 3(3-0) S
Prerequisite: Six hours of European history above the introductory level or consent of department

The course traces the evolutionary development of the government of the empire from Augustus through Marcus Aurelius. Mr. Riddle

HI 529 REVOLUTIONARY EUROPE, 1760-1792 3(3-0) F
Prerequisite: Six hours of European history above the introductory level or consent of department

An intensive study of the background of revolutionary ideas and events in Europe during the period indicated Mr. Greenlaw

HI 530 REVOLUTIONARY EUROPE, 1792-1815 3(3-0) S
Prerequisite: Six hours of European history above the introductory level or consent of department

An intensive study of revolutionary events in France and especially of their impact upon Europe in this period. Mr. Greenlaw

HI 531 HISTORY OF GREAT BRITAIN, 1714-1820 3(3-0) F
Prerequisite: Six hours of European history above the introductory level or consent of department

A study in depth of constitutional, religious and economic ideas and institutions in eighteenth century Britain. Mr. Downs

HI 532 HISTORY OF GREAT BRITAIN, 1820-1914 3(3-0) S
Prerequisite: Six hours of European history above the introductory level or consent of department

A study in depth of constitutional, religious and economic ideas and institutions of nineteenth century Britain. Mr. Downs

HI 535 DIPLOMATIC HISTORY OF EUROPE, 1815-1878 3(3-0) F
Prerequisite: Six hours of European history above the introductory level or consent of department

An analysis of the nature of European diplomatic relations from the Congress of Vienna to the Congress of Berlin. Mr. Brown

HI 536 DIPLOMATIC HISTORY OF EUROPE, 1878-1939 3(3-0) S
Prerequisite: Six hours of European history above the introductory level or consent of department

A study of diplomatic history of Europe from the Congress of Berlin through the reemergence of the system of balance of power and the repercussions of imperialism, the diplomatic aspects of the World Wars, and the attempts at solving world problems by means of diplomacy. Mr. Brown

HI 549 RECENT U. S. HISTORY, 1912-33 3(3-0) F
Prerequisite: Six hours of American history or consent of department

An intensive examination of the major events in American life in the opening years of the twentieth century. Mr. Beers

HI 550 RECENT U. S. HISTORY, 1933-PRESENT 3(3-0) S
Prerequisite: Six hours of American history or consent of department

An intensive examination of the major events in American life in the middle years of the twentieth century. Mr. Beers

HI 551 HISTORY AND PRINCIPLES OF THE ADMINISTRATION OF ARCHIVES
AND MANUSCRIPTS 3(3-0) F
Prerequisite: Six hours of American history or consent of department

A study of the nature, importance and use of original manuscript resources; the history and evolution of written records and the institutions administering them. Mr. Jones

HI 552 APPLICATION OF PRINCIPLES OF ADMINISTRATION OF ARCHIVES
AND MANUSCRIPTS 3(3-0) S
Prerequisite: Six hours of American history or consent of department

Internship training in the application of the principles and practices of archival management. Mr. Jones

HI 561 U. S. FAR EASTERN POLICY, 1842-1922 3(3-0) F
Prerequisite: Six hours of American history or consent of department

A study of the character and development of the basic principles of American policy in the Far East from their origin to their incorporation in treaties at the Washington Disarmament Conference. Mr. Beers

HI 562 U. S. FAR EASTERN POLICY, 1922-PRESENT 3(3-0) S
Prerequisite: Six hours of American history or consent of department

A study of the character and development of the basic principles of American policy in the Far East from the end of World War I to the present. Mr. Beers

HI 563 SOCIAL AND ECONOMIC HISTORY OF THE UNITED STATES TO
1860 3(3-0) F
Prerequisite: Six hours of American history or consent of department

A study of the social and economic ideas and institutions important in American life from the colonial period up to the Civil War. Miss King

HI 564 SOCIAL AND ECONOMIC HISTORY OF THE UNITED STATES SINCE
1860 3(3-0) S
Prerequisite: Six hours of American history or consent of department

A study of the social and economic ideas and institutions important in American life since the beginning of the Civil War. Miss King

HI 571 HISTORY OF SOVIET RUSSIA TO 1930 3(3-0) F
Prerequisite: Six hours of European history above the introductory level or consent of department

An analysis of the origins and effects of the 1917 revolutions and the domestic and foreign policies of the new Soviet regime to 1930. Mrs. Wheeler

HI 572 HISTORY OF SOVIET RUSSIA SINCE 1930 3(3-0) S
Prerequisite: Six hours of European history above the introductory level or consent of department

An analysis of the domestic and foreign policies of the Soviet Union since 1930 with special emphasis on the period since 1945. Mrs. Wheeler

FOR GRADUATES ONLY

HI 601 HISTORIOGRAPHY AND HISTORICAL METHOD 3(3-0) F
Prerequisite: Open only to graduate students in history

A study of the major steps in the development of historical investigation and writing from classical times to the present, as well as an analysis of the elements of good historical research and writing with some discussion of the methodology used by the contemporary scholarly historian. Graduate Staff

HI 602 SEMINAR IN AMERICAN HISTORY 3(3-0) S
Prerequisite: Open to graduate students in history only

A small research seminar on special topics in American history. Graduate Staff

HI 604 SEMINAR IN EUROPEAN HISTORY 3(3-0) S
Prerequisite: Open to graduate students in history only

A small research seminar on special topics in European history. Graduate Staff

HI 606 SEMINAR IN DIPLOMATIC HISTORY 3(3-0) S
Prerequisite: Open to graduate students in history only

A small research seminar on topics in diplomatic history. Mr. Brown

HI 699 RESEARCH IN HISTORY Credits Arranged
Prerequisite: Open to graduate students in history only

Individual research under graduate thesis supervisor. Graduate Staff

HORTICULTURAL SCIENCE

GRADUATE FACULTY

Professor CLIVE W. DONOHO, JR., *Head*

Professors: WALTER E. BALLINGER, FRED D. COCHRAN, FRANK L. HAYNES, JR., JOHN M. JENKINS, JR., LEATON J. KUSHMAN, CLARENCE L. MCCOMBS, DANIEL T. POPE; *Associate Professors:* THOMAS F. CANNON, GENE J. GALLETTA, WARREN R. HENDERSON, ROY A. LARSON, CONRAD H. MILLER; *Assistant Professor:* PAUL V. NELSON

The Department of Horticultural Science offers the Master of Science degree and the professional degree, Master of Horticulture. Evidence of high scholastic achievement in the basic biological sciences is particularly desirable for students who expect to study for the Master of Science degree in horticulture.

The department has excellent greenhouses, laboratories, cold storages and access to adequate field plots for graduate training in crop production, plant

propagation, nutrition and physiology, biochemistry, morphology, plant breeding, cytology and post-harvest physiology. The greenhouse range covers over 30,000 square feet and has 21 sections, each containing individual temperature and light control equipment. Laboratory facilities include four analytical laboratories, two cytological and anatomical laboratories, one soil testing laboratory for greenhouse control, one radioisotope laboratory and one landscape laboratory. Post-harvest facilities include, additionally, 14 controlled temperature storage rooms and grading, washing and packaging equipment. These combined facilities provide a wide variety of opportunities in basic and technical research in the horticultural field. An extensive and varied assortment of plant materials is available for use in graduate programs.

The wide variations in climate and soils in North Carolina, from the coast to the mountains, make possible the study of plant responses under these varied conditions. Land and facilities for horticultural research are available on 10 of the outlying stations located throughout North Carolina.

The opportunities for employment after advanced training include teaching and research in state and privately endowed educational institutions; research and regulatory positions with the United States Department of Agriculture, both foreign and domestic; extension specialists and county agents; research, production and promotional work with food, chemical and seed concerns; orchard, nursery and greenhouse supervisors; and inspectors and quality control technologists.

FOR ADVANCED UNDERGRADUATES

HS 411 NURSERY MANAGEMENT

3(2-3) F

Prerequisites: BS 100, SSC 200

The principles and practices involved in the production, management and marketing of field-grown and container-grown nursery plants. Field trips will be taken. (Offered fall of 1968-69 and alternate years.)

HS 421 FRUIT PRODUCTION

3(2-3) F

Prerequisites: BS 100, SSC 200

A study of identification, adaptation and methods of production and marketing of the principal trees and small fruits. Modern practices as related to selection of sites, nutritional requirements, management practices and marketing procedures will be discussed.

HS 432 VEGETABLE PRODUCTION

3(2-3) F

Prerequisites: BS 100, SSC 200

A study of the origin, importance, distribution, botanical relationships and principles of production and marketing of the major vegetable crops.

HS 441 FLORICULTURE I

3(2-3) F

Prerequisites: BS 100, SSC 200

The scope and importance of the commercial flower industry; the basic principles and practices involved in the production and marketing of flowers grown in the greenhouse and in the field. (Offered fall of 1967-68 and alternate years.)

HS 442 FLORICULTURE II 3(2-3) S
Prerequisites: BS 100, SSC 200

Principles and methods of production of commercial flower crops in the greenhouse and in the field, including fertilization, moisture, temperature and light relationships, insect and disease control, and marketing of cut flowers and pot plants. (Offered spring of 1967-68 and alternate years.)

HS 471 ARBORICULTURE 3(2-2) S
Prerequisites: BS 100, SSC 200

A study of the principles and practices in the care and maintenance of ornamental trees and shrubs, such as pruning, fertilization, control of insects and diseases, and tree surgery. Field trips will be taken. (Offered spring of 1967-68 and alternate years.)

HS 481 BREEDING OF HORTICULTURAL PLANTS 3(2-2) F
Prerequisite: GN 411

The application of genetics and other biological sciences to the improvement of horticultural crops.

HS 491 SENIOR SEMINAR 1(1-0) FS
Prerequisite: Senior standing in horticultural science

Presentation of scientific articles, progress reports in research and special problems in horticulture and related fields.

FOR GRADUATES AND ADVANCED UNDERGRADUATES

HS 541 (CS 541, GN 541) PLANT BREEDING METHODS 3(3-0) F
(See Crop Science, page 95.)

HS 542 (CS 542, GN 542) PLANT BREEDING FIELD PROCEDURES 2(0-4) Sum.
(See Crop Science, page 95.)

HS 552 GROWTH OF HORTICULTURAL PLANTS 3(2-3) S
Prerequisite: BO 421

A study of the effect of nutrient-elements, water, light, temperature and growth substances on growth and development of horticultural plants. Mr. McCombs

HS 562 POST-HARVEST PHYSIOLOGY 3(3-0) S
Prerequisite: BO 421

A study of chemical and physiological changes that occur during handling, transportation and storage which affect the quality of horticultural crops. Consideration will be given to pre- and post-harvest conditions which influence these changes. Mr. Ballinger

HS 599 RESEARCH PRINCIPLES Credits Arranged
Prerequisite: Consent of instructor

Investigation of a problem in horticulture under the direction of the instructor. The students obtain practice in experimental techniques and procedures, critical

review of literature and scientific writing. The problem may last one or two semesters. Credits will be determined by the nature of the problem, not to exceed a total of four hours. Graduate Staff

FOR GRADUATES ONLY

HS 613 (CS 613, GN 613) PLANT BREEDING THEORY 3(3-0) S
(See Crop Science, page 96.)

HS 621 METHODS AND EVALUATION OF HORTICULTURAL RESEARCH 3(3-0) F
Prerequisite: Graduate standing

Principles and methods of research in the field of horticulture and their application to the solution of current problems. Critical study and evaluation of scientific publications. Compilation, organization and presentation of data.

Mr. Cochran

HS 691 SEMINAR 1(1-0) FS
Prerequisite: Graduate standing

Required of all horticultural science graduate students.

Presentation of scientific articles and special lectures. Students will be required to present one or more papers. Graduate Staff

HS 699 RESEARCH Credits Arranged
Prerequisites: Graduate standing in horticulture, consent of advisory committee chairman

A maximum of six credits is allowed toward the Master of Science degree; no limitation on credits in doctoral program.

Original research on specific problems in fruit, vegetable and ornamental crops. Graduate Staff

INDUSTRIAL AND TECHNICAL EDUCATION

GRADUATE FACULTY

Professor DURWIN M. HANSON, *Head*

Professors: JOSEPH T. NERDEN, DELMAR W. OLSON, *Coordinator, Graduate Studies in Ind. Arts;* *Associate Professors:* TALMAGE B. YOUNG, *Coordinator, Undergraduate Studies in Industrial Arts,* CARL A. MOEL-
LER

The Department of Industrial and Technical Education offers graduate work leading to the degrees of Master of Science, Master of Education and Doctor of Education. The rapid development of industrial arts education and industrial and technical education in North Carolina and throughout the nation provides many opportunities for teachers, supervisors and administrators who have earned advanced degrees.

The facilities at the University afford an excellent program of supporting courses at the graduate level in the related fields of science, mathematics, guidance and personnel services, psychology, sociology, economics, statistics and engineering. The prerequisite for graduate work in the Department of Industrial and Technical Education is a proficiency in the undergraduate courses required for the bachelor's degree in industrial arts education,

industrial or technical education, or a substantial equivalent.

A limited number of teaching and research assistantships and fellowships are available for qualified graduate students.

FOR GRADUATES AND ADVANCED UNDERGRADUATES

ED 516 COMMUNITY OCCUPATIONAL SURVEYS 2(2-0) S
Prerequisites: Six hours in education, consent of instructor

Methods in organizing and conducting local and regional surveys, and procedures in making evaluations of the data gathered in these surveys for the planning of programs of vocational and technical education. Economic, sociological and other demographic factors are explored, and procedures for obtaining valid data concerning these factors are studied.
Mr. Hanson

ED 525 TRADE ANALYSIS AND COURSE CONSTRUCTION 3(3-0) F
Prerequisites: ED 344, PSY 304

Principles and practices in analyzing occupations for the purpose of determining teaching content. Practice in the principles underlying industrial and technical course organization based on occupational analyses covering instruction in skills and technology and including course outlines, job sequences, the development of instructional materials and schedules.
Mr. Hanson

ED 527 PHILOSOPHY OF INDUSTRIAL AND TECHNICAL EDUCATION 3(3-0) F
Prerequisites: ED 422, ED 440

A presentation of the historical development of industrial and technical education in relation to the broad field of vocational education; philosophies of vocational education and the resulting types of programs; trends and problems related to vocational-industrial education; study of local, state and federal legislation which pertains to vocational education.
Messrs. Hanson, Nerden

ED 529 CURRICULUM MATERIALS DEVELOPMENT 3(3-0) FS
Prerequisite: ED 525

This course deals with the procedures used in analyzing skills, technical knowledge and general education which has a bearing upon the ultimate development of curriculum for programs of vocational education. Emphasis is placed upon the selection and organization of curricula used in vocational and technical education, and also the development of curricula and instructional materials.
Mr. Hanson

ED 591 SPECIAL PROBLEMS IN INDUSTRIAL EDUCATION Maximum 6
Prerequisites: Six hours graduate work, consent of department head

Directed study, other than a thesis problem, in order to provide individualized instruction and analysis in a specialized area of industrial or technical education. Under guidance, the graduate student may select a problem which has equal value from the standpoint of scholarship and utilitarian purposes, and develop the problem into a practical document.
Messrs. Hanson, Nerden

IA 510 DESIGN FOR INDUSTRIAL ARTS TEACHERS 3(2-2) Sum.
Prerequisites: Six hours of drawing, IA 205 or equivalent

A study of new developments in the field of design with emphasis on the relationship of material and form in the selection and designing of industrial arts projects.
Graduate Staff

IA 560 (ED 560) NEW DEVELOPMENTS IN INDUSTRIAL ARTS**EDUCATION****3(3-0) Sum.****Prerequisites:** Twelve hours in education and teaching experience

This course is a study of the new developments in industrial arts education. It is designed to assist teachers and administrators in developing new concepts and new content based on the changes in technology. They will be required to reevaluate their programs in the light of these new concepts and the new content.

Mr. Olson, Graduate Staff**IA 590 LABORATORY PROBLEMS IN INDUSTRIAL ARTS****Maximum 6****Prerequisites:** Senior standing, consent of instructor

Courses based on individual problems and designed to give advanced majors in industrial arts education the opportunity to broaden or intensify their knowledge and abilities through investigation and research in the various fields of industrial arts, such as metals, plastics, ceramics or electricity-electronics.

Graduate Staff**IA 592 SPECIAL PROBLEMS IN INDUSTRIAL ARTS****Maximum 6****Prerequisite:** One term of student teaching or equivalent

The purpose of this course is to broaden the subject matter experiences in the areas of industrial arts. Problems involving curriculum, investigation or research in one or more industrial arts areas will be required.

Graduate Staff**IA 595 (ED 595) INDUSTRIAL ARTS WORKSHOP****3(3-0) Sum.****Prerequisite:** One or more years of teaching experience

A course for experienced teachers, administrators and supervisors of industrial arts. The primary purpose will be to develop sound principles and practices for initiating, conducting and evaluating programs in this field. Enrollees will pool their knowledge and practical experiences and will do intensive research work on individual and group problems.

Graduate Staff**FOR GRADUATES ONLY****ED 608 SUPERVISION OF VOCATIONAL AND INDUSTRIAL ARTS****EDUCATION****3(3-0) F**

(See Education, page 108.)

ED 609 PLANNING AND ORGANIZING TECHNICAL EDUCATIONAL PROGRAMS**3(3-0) FS****Prerequisites:** ED 344, ED 420, ED 440, ED 516, PSY 304

Principles of planning and procedures in organizing programs of vocational and technical education, especially those dependent upon state and federal legislation. Professional course for coordinators and directors of local systems of vocational education, and for supervisors and administrators of vocational and technical programs on the county, regional and state levels. Emphasis is placed upon the organization of high school, post-high school and adult technical education programs. Course includes a survey of educational needs, plans for constructing, equipping and maintaining buildings, with special attention given to the financing of the program of technical education, the staffing and management aspects.

Messrs. Hanson, Nerden**ED 610 ADMINISTRATION OF VOCATIONAL AND INDUSTRIAL ARTS
EDUCATION****3(3-0) S**

(See Education, page 108.)

- ED 611 LAWS, REGULATIONS AND POLICIES AFFECTING VOCATIONAL EDUCATION** 3(3-0) FS
 Prerequisites: ED 527, ED 610 or equivalent

A detailed study of legislation (national and state) which applies directly to vocational education. Basic social and economic issues which precipitated the legislation are studied in depth; also the socioeconomic impact of the legislation is reviewed. Emphasis is placed upon the organizational structure and the operating policies under which national and state legislation is converted into programs of vocational and technical education.
 Mr. Nerden, Graduate Staff

- ED 612 FINANCE, ACCOUNTING AND MANAGEMENT OF VOCATIONAL EDUCATION PROGRAMS** 3(3-0) FS
 Prerequisites: ED 527, ED 610 or equivalent

A detailed study of the factors which affect the financing of programs of vocational education. Special emphasis is placed upon the social, economic, political and power factors which impinge upon the procedures which are generally followed in financing vocational and technical education. Study is made of the matter of financing new vocational enterprises, as well as the study of the continuing costs of established programs. Costs of operation, procedures for the purchase of equipment, costs of new building construction and other aspects of finance in vocational education are studied in detail.

Mr. Nerden, Graduate Staff

- ED 630 PHILOSOPHY OF INDUSTRIAL ARTS** 2(2-0) FS
 Prerequisites: Twelve hours in education
 Required of all graduate students in industrial arts education.

Current and historical developments in industrial arts; philosophical concepts, functions, scope, criteria for the selection and evaluation of learning experiences, laboratory organization, student personnel program, community relationships, teacher qualifications and problems confronting the industrial arts profession.
 Graduate Staff

- ED 635 ADMINISTRATION AND SUPERVISION IN INDUSTRIAL ARTS** 2(2-0) FS
 Prerequisites: Twelve hours in education

A study of the problems and techniques of administration and supervision in the improvement of industrial arts in the public schools. Selection of teachers and their improvements in service, and methods of evaluating industrial arts programs.
 Mr. Young

- ED 691 SEMINAR IN INDUSTRIAL EDUCATION** 1(1-0) FS
 Prerequisite: Graduate standing or consent of instructor

Reviews and reports of topics of special interest to graduate students in industrial and technical education. The course will be offered in accordance with the availability of distinguished professors, and in response to indicated needs of the graduate students.
 Mr. Hanson

- ED 692 SEMINAR IN INDUSTRIAL ARTS EDUCATION** 1(1-0) FS
 Prerequisite: Graduate standing

Reviews and reports on special topics of interest to students in industrial arts education.
 Graduate Staff

INDUSTRIAL ENGINEERING

GRADUATE FACULTY

Professor CLIFTON A. ANDERSON, *Head*

Professors: ROBERT G. CARSON, JR., SALAH E. ELMAGHRABY, JAY GOLDMAN, ROBERT W. LLEWELLYN*; *Associate Professors:* RAUL E. ALVAREZ, JOHN R. CANADA, JOHN J. HARDER, R. G. PEARSON; *Assistant Professor:* H. A. KNAPPENBERGER

The Department of Industrial Engineering offers programs of graduate study leading to the Master of Science and the Doctor of Philosophy degrees. While each individual student's plan of study is specifically tailored to meet his own personal desires and professional needs, the departmental course offerings stress three main themes of industrial engineering. These focal points are quantitative decision-making, human factors and work systems design, and production processes. Courses and research in each of these areas are available within the department.

Each candidate is expected to include within his study plan, one or more minor areas of study. The minor departments cooperate in many interdisciplinary research projects and make their facilities available to industrial engineering graduate students. The Triangle Universities Computing Center also provides a facility second to none in the world. The equipment consists of an IBM System/360, Model 75 Computer as the main unit with an IBM System 360, Model 30 as a high-speed remote terminal on the N. C. State campus.

The course offerings shown below reflect the latest technology as applied to planning, operating and controlling manufacturing, distribution and service enterprises. In addition, the department's educational philosophy allows for maximum flexibility while providing the depth of understanding so necessary in a graduate research program in industrial engineering.

FOR ADVANCED UNDERGRADUATES

IE 401 INDUSTRIAL ENGINEERING ANALYSIS I

3(3-0) F

Prerequisites: IE 353, MA 405

A study of linear programming methods and their applications in industrial engineering; the transportation method with applications to scheduling in transportation and production problems; the simplex method and its applications in production planning, production scheduling and allied fields; upper bound, integer, parametric and primal-dual methods with their typical applications; the interrelationships between linear programming and game theory.

IE 402 INDUSTRIAL ENGINEERING ANALYSIS II

3(3-0) S

Prerequisite: IE 401

An introductory study of several aspects of operations research methods with emphasis on their industrial engineering applications; replacement theory, sequencing problems, inventory control methods and dynamic programming and their applications.

* On leave of absence

IE 403 INDUSTRIAL ENGINEERING ANALYSIS III

3(3-0) S

Prerequisite: IE 401

An introductory study of several aspects of operations research methods with emphasis on their industrial engineering applications; continuous and discrete cybernetics with emphasis on Markov processes; finite and infinite queuing models; industrial control methods and industrial dynamics.

IE 421 DATA PROCESSING AND PRODUCTION CONTROL SYSTEMS

3(3-0) F

Prerequisites: IE 352, introductory course in computer programming

This course is an introduction to the design of integrated control systems necessary for effective management of production. It will include the methods of systems design, the basic concepts of computer processing systems, the design of control procedures and reports, and their application to mechanized and electronic data processing equipment. Major emphasis will be placed on the design of control procedures for production scheduling, labor performance and quality control. Systems flow charts, block diagrams and program statements in compiler form will be used for each system application

IE 441 (PSY 441) HUMAN FACTORS IN EQUIPMENT DESIGN

3(2-2) S

Prerequisites: IE 352 or PSY 337 or EC 426 or consent of instructor

An introduction to methodology in laboratory research, equipment design, anthropometry, and accident study. Man's sensory, motor and decision-making abilities are related to problems of systems design, operator efficiency, and safety as these involve displays, controls, workplace layout, and environment stressors.

IE 453 OPERATIONS PLANNING AND PLANT LAYOUT

3(2-3) F

Prerequisite: IE 352

This course will provide an opportunity for the student to apply the basic principles contained in the prerequisite course to the design of plantwide production programs with emphasis placed on planning, arrangement, layout and implementation of such programs. It will include operations sequencing, tooling and equipment selection, materials handling, systems design, manpower and facilities forecasting. Suitable cases will be drawn from both mass production and jobbing operations.

FOR GRADUATES AND ADVANCED UNDERGRADUATES**IE 505 (MA 505, OR 505) MATHEMATICAL PROGRAMMING I**

3(3-0) F

Prerequisite: MA 405

A study of mathematical methods applied to problems of planning. Linear programming will be covered in detail. This course is intended for those who desire to study this subject in depth and detail. It provides a rigorous and complete development of the theoretical and computational aspects of this technique as well as a discussion of a number of applications.

Mr. Alvarez

IE 511 ADVANCED ENGINEERING PROJECT ANALYSIS

3(3-0) F

Prerequisites: IE 311, ST 421

Analysis of project economy models with certainty assumed, advantages and limitations of models, effects of income tax and depreciation methods. Risk analyses employing probability concepts, sensitivity studies and measures of utility. Estimation techniques and use of accounting information, time series analysis and judgment factors. Planning and uses of capital funds.

Mr. Canada

IE 515 PROCESS ENGINEERING**3(3-0) F****Prerequisites:** IE 328, IE 443

The technical process of translating product design into a manufacturing program. The application of industrial engineering in the layout, tooling, methods, standards, costs and control functions of manufacturing. Laboratory problems covering producer and consumer products.

Mr. Harder**IE 517 AUTOMATIC PROCESSES****3(3-0) S****Prerequisites:** IE 328, IE 443

Principles and methods for automatic processing. The design of product, process and controls. Economic, physical and sociological effects of automation.

Mr. Harder**IE 521 CONTROL SYSTEMS AND DATA PROCESSING****3(3-0) F****Prerequisite:** IE 421

This course presents the problems and techniques required for systematic control of the production process and the business enterprise. This includes the determination of control factors, the collection and recording of data, and the processing, evaluation and use of data. The course will illustrate the applications and use of data processing equipment and information machines in industrial processes. Case problems will be used extensively.

Graduate Staff**IE 522 (OR 522) DYNAMICS OF INDUSTRIAL SYSTEMS****3(3-0) F****Prerequisite:** IE 421

A study of the dynamic properties of industrial systems; introduction to servo-mechanism theory as applied to company operations. Simulation of large non-linear, multiloop, stochastic systems on a digital computer; methods of determining modifications in systems design and/or operating parameters for improved system behavior.

Graduate Staff**IE 540 (PSY 540) HUMAN FACTORS IN SYSTEMS DESIGN****3(3-0) S****Prerequisites:** IE 441 (PSY 441), ST 513 or ST 515 or consent of instructor

Introduction to problems of the systems development cycle, including man-machine function allocation, military specifications, display-control compatibility, the personnel subsystem concept, and maintainability design. Detailed treatment is given to man as an information processing mechanism.

Mr. Pearson**IE 543 STANDARD DATA****3(3-0) S****Prerequisite:** IE 332

Theory and practice in developing standard data from stop-watch observations and predetermined time data; methods of calculating standards from data; application of standard data in cost control, production planning and scheduling, and wage incentives.

Mr. Goldman**IE 546 ADVANCED QUALITY CONTROL****3(3-0) S****Prerequisites:** IE 353, ST 421

The statistical foundations of quality control are emphasized as well as its economic implications. Mathematical derivations of most of the formulas used are given. Sampling techniques are treated extensively and many applications of this powerful technique are explained.

Mr. Knappenberger**IE 547 ENGINEERING RELIABILITY****3(3-0) F****Prerequisites:** IE 353, ST 421

The methodology of reliability including application of discrete and continuous distribution models and statistical designs; reliability estimation, reliability structure models, reliability demonstration and decision, and reliability growth models. Example of reliability evaluation and demonstration programs.

Mr. Knappenberger

IE 591 PROJECT WORK

2-6 FS

Prerequisite: Graduate or senior standing

Investigation and report on an assigned problem for students enrolled in the fifth-year curriculum in industrial engineering.

Graduate Staff

FOR GRADUATES ONLY

IE 607 (MA 607, OR 607) SELECTED TOPICS IN MATHEMATICAL PROGRAMMING

3(3-0) S

Prerequisite: IE 505

This course is a continuation of IE 505 (MA 505). Special techniques like the decomposition principles, network problems, diophantine programming as well as its applications to industrial problems are studied. An introduction to dynamic programming will also be covered. Multistage decision problems will be worked using linear and dynamic programming. The theoretical foundation of these techniques will be covered but emphasis will be in the applications to planning problems.

Graduate Staff

IE 608 LINEAR PROGRAMMING APPLICATIONS

3(3-0) S

Prerequisite: IE 505 or EC 555

The application of linear programming to large problems of a practical nature; product mix, diet, scheduling and blending problems; problem generation, control of accuracy, report generation. Stress is laid on post-optimal studies; multiple-objective functions and right-hand sides; parametric programming on the right-hand side, the objective functions, the rim and the interior. Decomposition and piecewise linear applications in specialized problem areas.

Graduate Staff

IE 621 (OR 621) INVENTORY CONTROL METHODS I

3(3-0) S

Prerequisites: IE 402, MA 511, ST 421

A study of inventory policy with respect to reorder sizes, minimum points and production schedules. Simple inventory models with restrictions, price breaks, price changes, analysis of slow-moving inventories. Introduction to the smoothing problem in continuous manufacturing. Applications of linear and dynamic programming and zero-sum game theory.

Mr. Alvarez

IE 622 INVENTORY CONTROL METHODS II

3(3-0) F

Prerequisite: IE 621

A continuation of IE 621; stochastic inventory systems of lot size-reorder type; periodic review and single period models. Application of dynamic programming theory to deterministic and stochastic cases.

Graduate Staff

IE 631 PRODUCTION CONTROL SYSTEMS I

3(3-0) S

Prerequisites: IE 521, ST 421

The application of analytical techniques and computer simulation to the problem of devising systems for the control of production processes. Transition matrices describing the flow of work through productive facilities provide for expression of the entire spectrum of organizations for production, from pure assembly lines to pure job shops. Emphasis will be placed on the cost versus

effectiveness of various techniques for planning shop forecasts, daily versus longer-horizon schedules and production order flow. Graduate Staff

IE 632 PRODUCTION CONTROL SYSTEMS II 3(3-0) F
Prerequisite: IE 631

This course will provide an opportunity for the student to apply analytical techniques to a spectrum of production control problems. The course will provide insight into the problems inherent in applying advanced techniques to operating situations. The effects of data and model inadequacies will be covered in production situations ranging from assembly line balancing to job shop sequencing. Students will develop analytical or simulation models in case studies.

Graduate Staff

IE 640 (PSY 640) SKILLED OPERATOR PERFORMANCE 3(3-0) F
Prerequisites: IE 540 (PSY 540) or consent of instructor

Theories of the human operator are considered with regard to the classical problems of monitoring, vigilance, and tracking. Factors such as biological rhythm, sleep loss, sensory restriction, environmental stress and time-sharing are considered as they interact with and determine overall systems efficiency. (Offered in alternate years.)

Mr. Pearson

IE 641 BIOTECHNOLOGY IN SYSTEMS ENGINEERING 3(3-0) F
Prerequisites: IE 540 (PSY 540) or consent of instructor, ZO 421 recommended

Study of major problem areas, methodology, theory and experimental work in biotechnology; interaction among engineering, biological and behavioral factors in design for safety and survival; physiology and biomechanics of acceleration, deceleration and pressure altitude; consideration of operator effectiveness in submarine, extraterrestrial, arctic and desert environments; techniques in evaluation of crash dynamics and pathology; closed-ecological systems. (Offered in alternate years.)

Mr. Pearson

IE 651 SPECIAL STUDIES IN INDUSTRIAL ENGINEERING Credits Arranged
Prerequisite: Graduate standing

The purpose of this course is to allow individual students or small groups of students to undertake studies of special areas in industrial engineering which fit into their particular program and which may not be covered by existing industrial engineering graduate level courses. The work would be directed by a qualified staff member who has particular interest in the area covered by the problem. Such problems may require individual research and initiative in the application of industrial engineering training to new areas or fields.

Graduate Staff

IE 695 SEMINAR 1(1-0) FS
Seminar discussion of industrial engineering problems for graduate students. Case analyses and reports.

Mr. Goldman

IE 699 INDUSTRIAL ENGINEERING RESEARCH Credits Arranged
Graduate research in industrial engineering for thesis credit. Graduate Staff

MATHEMATICS

GRADUATE FACULTY

Professor HUBERT V. PARK, *Acting Head*

Professors: ROBERTS C. BULLOCK, JOHN M. CLARKSON, JOHN M. DANBY,

WALTER J. HARRINGTON, JACK LEVINE, PAUL E. LEWIS, CAREY G. MUMFORD, HOWARD M. NAHIKIAN, *Graduate Administrator*, PAUL A. NICKEL, HANS SAGAN, HERBERT E. SPEECE, RAIMOND A. STRUBLE, HUBERTUS R. VAN DER VAART, OSCAR WESLER, LOWELL S. WINTON; *Adjunct Professors*: ALAN S. GALBRAITH, IAN N. SNEDDON; *Visiting Professors*: MAKOTO ITOH, CORNELIUS LANZOS; *Associate Professors*: JOHN W. BISHIR, ERNEST E. BURNISTON, RICHARD E. CHANDLER, KWANGIL KOH, JOHN W. QUERRY, JOSEPH D. ZUND; *Assistant Professors*: DONALD J. HANSEN, JOE A. MARLIN, DAVID F. ULLRICH

The Department of Mathematics offers graduate studies in applied mathematics leading to the Master of Applied Mathematics, the Master of Science and the Doctor of Philosophy degrees. The Master of Applied Mathematics degree requires a departmental paper, but does not require a thesis or a foreign language. In all other respects it is the same as the Master of Science degree. Students who are admitted to the Graduate School to pursue studies in applied mathematics are expected to have had a strong undergraduate major in mathematics, including a year of advanced calculus and a year of modern algebra including abstract algebra and matrices. Those students who do not have these courses will be required to take them in addition to the minimum number required for the master's degree. The areas of application require that the student offer a minor in some mathematically oriented area such as physics, the engineering sciences, genetics or statistics.

Individuals with graduate training in applied mathematics are in great demand in industry, governmental laboratories and college teaching positions. Opportunities are many and varied in this field and include work as a member of a research team in such areas as satellite orbit theory, viscoelasticity, biomathematics, thermodynamics, aerodynamics, acoustics, solid-state physics, nuclear reactor theory, geophysics and in applications of computers in business.

The department has available a number of teaching and research assistantships (a student holding a half-time assistantship is allowed to carry a study load of nine semester hours). Also available for those graduate students studying toward the doctoral degree are a limited number of NSF, NASA and Ford Foundation Fellowships. The Department of Mathematics requires that Graduate Record Exam scores, including the advanced test in mathematics, be submitted by all applicants.

FOR ADVANCED UNDERGRADUATES

MA 401 INTERMEDIATE DIFFERENTIAL EQUATIONS 3(3-0) FS
Prerequisite: MA 301

Infinite series and integrals; linear differential equations; special functions.

MA 403 FUNDAMENTAL CONCEPTS OF ALGEBRA 3(3-0) FS
Prerequisite: MA 202 or MA 212 (one year of calculus)

Natural numbers; integral domains; rational numbers; fields, rings, groups, Boolean algebra, general algebraic structures.

MA 404 FUNDAMENTAL CONCEPTS OF GEOMETRY 3(3-0) S

Prerequisite: MA 202 or MA 212 (one year of calculus)

Foundations of geometry; laws of logic; affine geometry; geometric transformations; homogeneous coordinates; comparison of Euclidean and non-Euclidean geometries.

MA 405 INTRODUCTION TO DETERMINANTS AND MATRICES 3(3-0) FS

Prerequisite: MA 202 or MA 212

Properties of determinants; theorems of Laplace and Jacobi; systems of linear equations. Elementary operations with matrices; inverse, rank, characteristic roots and eigenvectors. Introduction to algebraic forms.

MA 408 ADVANCED GEOMETRY 3(3-0) F

Prerequisite: MA 202 or MA 212

Topics from modern geometry; poles and polars; non-Euclidean geometry; analytical geometry from a vector point of view; elementary geometry from an advanced standpoint.

MA 421 INTRODUCTION TO PROBABILITY 3(3-0) FS

Prerequisite: MA 301 or consent of department

Definitions, discrete and continuous sample spaces, combinatorial analysis, Stirling's formula, simple occupancy and ordering problems, conditional probability, repeated trials, compound experiments, Bayes' theorem, binomial, Poisson and normal distribution, the probability integral, random variables, expectation.

MA 433 HISTORY OF MATHEMATICS 3(3-0) S

Prerequisite: MA 202 or MA 212

Evolution of the number system; trends in the development of modern mathematics; lives and contributions of outstanding mathematicians.

MA 481 SPECIAL TOPICS 1-6 FS

Prerequisite: Consent of department

MA 491 READING IN HONORS MATHEMATICS 2-6 FS

Prerequisites: Membership in honors program, consent of department head

FOR GRADUATES AND ADVANCED UNDERGRADUATES**MA 505 (IE 505, OR 505) MATHEMATICAL PROGRAMMING I 3(3-0) F**
(See Industrial Engineering, page 171.)**MA 508 MATHEMATICAL ANALYSIS I 3(3-0) F**

Prerequisite: MA 222 or equivalent

A course designed primarily for mathematics majors as preparation for the study of real variable theory. Sets, functions, countability, the real numbers, Cartesian spaces, norms, metrics, point set topology, sequences of constants and functions, series of constants. Graduate Staff

MA 509 MATHEMATICAL ANALYSIS II 3(3-0) S

Prerequisite: MA 508

Continuation of MA 508. Continuous functions, differentiation, integration, series of functions. Graduate Staff

MA 511 ADVANCED CALCULUS I 3 (3-0) FS
Prerequisites: MA 301, preferably a B average in all mathematics courses

Vectors, differential calculus of functions of several variables, vector differential calculus. Definite integral. Graduate Staff

MA 512 ADVANCED CALCULUS II 3 (3-0) FS
Prerequisite: MA 511

Vector integral calculus, infinite series, integral calculus of functions of several variables. Graduate Staff

MA 513 INTRODUCTION TO COMPLEX VARIABLES 3 (3-0) FS
Prerequisite: MA 511 or MA 508

Operations with complex numbers, derivatives, analytic functions, integrals, definitions and properties of elementary functions, multivalued functions, power series, residue theory and applications, conformal mapping. Graduate Staff

MA 514 METHODS OF APPLIED MATHEMATICS 3 (3-0) S
Prerequisite: MA 511 or MA 508

Introduction to integral equations, the calculus of variations and difference equations. Graduate Staff

MA 516 PRINCIPLES OF MATHEMATICAL ANALYSIS 3 (3-0) F
Prerequisite: MA 512

The real number system, elements of set theory, limits, continuity, differentiation, Reimann-Stieltjes integration, sequences of functions, fundamentals of Lebesgue theory, topological and metric spaces. Graduate Staff

MA 517 INTRODUCTION TO POINT SET TOPOLOGY 3 (3-0) S
Prerequisite: MA 509 or MA 512

A study of basic set-theoretic and general topological notions of modern mathematics. Topics include set theory and cardinal numbers, topological spaces, metric spaces and elementary discussion of function spaces. Graduate Staff

MA 521 A SURVEY OF MODERN ALGEBRA 3 (3-0) F
Prerequisite: MA 403 or consent of instructor

Elementary theory of groups including permutation groups, orbits, subgroups, factor groups, conjugate classes, Abelian groups, solvable nilpotent groups and Sylow subgroups. Elementary theory of rings including ideals and quotient rings, the field of quotients of an integral domain, Euclidean rings and polynomial rings. Elementary theory in fields. The elements of Galois Theory. Graduate Staff

MA 524 BOUNDARY VALUE PROBLEMS 3 (3-0) FS
Prerequisite: MA 511 or MA 508

Theory of the first variation with applications to various physical phenomena (vibrating string, vibrating membrane, heat conduction, wave propagation); Bernoulli's separation method with applications to vibration and heat conduction problems, Fourier series, the Sturm-Liouville Problem. Graduate Staff

MA 525 BOUNDARY VALUE PROBLEMS II 3 (3-0) FS
Prerequisite: MA 524

Theory of orthogonal functions as eigenfunctions of a Sturm-Liouville boundary value problem, Legendre and Bessel functions, extremum properties of eigenvalues, the method of Rayleigh-Ritz, Schrodinger's equation and spherical harmonics, nonhomogeneous boundary value problem and Green's function.

Graduate Staff

MA 527 NUMERICAL ANALYSIS I**3(3-0) FS****Prerequisite:** MA 511 or MA 508

Numerical solution of equations, introduction to the theory of errors, finite-differences tables and the theory of interpolation, numerical integration, numerical differentiation and elements of difference calculus.

Graduate Staff**MA 528 NUMERICAL ANALYSIS II****3(3-0) S****Prerequisite:** MA 527

Difference operators, summation procedures, numerical solution of ordinary differential equations, least-squares polynomial approximations and Gaussian quadrature.

Graduate Staff**MA 532 THEORY OF ORDINARY DIFFERENTIAL EQUATIONS****3(3-0) S****Prerequisite:** MA 511 or MA 508

First order equations, linear n^{th} order equations with constant coefficients and with continuous coefficients, Green's functions, solution of linear equations with analytic coefficients, second order linear equations with regular singular points, systems of first order equations, uniqueness theorems, existence theorems of Picard and Peano, stability of solutions of linear plane autonomous systems, numerical solutions.

Graduate Staff**MA 536 LOGIC FOR DIGITAL COMPUTERS****3(3-0) F****Prerequisite:** MA 405

Introduction to symbolic logic and Boolean algebra; finite state-valued calculus and its application to combinational networks; sequential finite-state machines and their mathematical formulation; analysis and synthesis problems of sequential machines.

Mr. Itoh**MA 537 MATHEMATICAL THEORY OF DIGITAL COMPUTERS****3(3-0) S****Prerequisite:** MA 536

The sequential machine and its characteristic semi-group; micro-programmed computers; general purpose computers and special-purpose computers; Turing machine and infinite-state machines; nondeterministic switching system and probabilistic automata.

Mr. Itoh**MA 541 (ST 541) THEORY OF PROBABILITY I****3(3-0) F****Prerequisite:** MA 508 or MA 511

Axioms, discrete and continuous sample spaces, events, combinatorial analysis, conditional probability, repeated trials, independence, random variables, expectation, special discrete and continuous distributions, probability and moment generating functions, central limit theorem, laws of large numbers, branching processes, recurrent events, random walk.

Mr. Bishir**MA 542 (ST 542) THEORY OF PROBABILITY II****3(3-0) S****Prerequisites:** MA 405, MA 541

Markov chains and Markov processes, Poisson process, birth and death processes, queuing theory, renewal theory, stationary processes, Brownian motion.

Mr. Bishir**MA 545 SET THEORY AND FOUNDATIONS OF MATHEMATICS****3(3-0) S****Prerequisites:** Senior standing, consent of department

Logic and the axiomatic approach, the Zermelo-Fraenkel axioms and other systems, algebra of sets and order relations, equivalents of the Axiom of Choice, one-to-one correspondences, cardinal and ordinal numbers, the Continuum Hypothesis.

Graduate Staff

MA 555 (PY 555) PRINCIPLES OF ASTRODYNAMICS 3(3-0) S
Prerequisites: MA 511, PY 411 or EM 312

The differential equations of motion in two-body problems and their integrals; orbit theory; integrals of the n-body; differential equations of motion of natural and artificial satellites and their approximate solutions. Mr. Danby

MA 556 APPLICATIONS OF CELESTIAL MECHANICS 3(3-0) S
Prerequisite: MA 555

Computations in Keplerian Motion; methods of numerical integration; geometrical and statistical bases of differential corrections and space navigation; and the practical application of general theories from an analytical point of view. Solutions by digital computer will be employed. Mr. Danby

MA 571 (BMA 571, BS 571, ST 571) BIOMATHEMATICS I 3(3-0) F
(See Biomathematics, page 137.)

MA 572 (BMA 572, BS 572, ST 572) BIOMATHEMATICS II 3(3-0) S
(See Biomathematics, page 138.)

MA 581 SPECIAL TOPICS 1-6
Prerequisite: Consent of department Graduate Staff

FOR GRADUATES ONLY

MA 602 PARTIAL DIFFERENTIAL EQUATIONS I 3(3-0) F
Prerequisite: Graduate standing in mathematics or consent of instructor

Equations in two independent variables: first order equations, boundary value problems for the principal second order types, theory of characteristics. Existence and uniqueness by majorant series and by successive approximations. Maximum principle. Approximation methods. Mr. Struble

MA 603 PARTIAL DIFFERENTIAL EQUATIONS II 3(3-0) S
Prerequisite: MA 602

Continuation of MA 602. Equations in many independent variables: relationships with the calculus of variations, generalizations of the concept of a solution and unifying concepts, applications. Mr. Struble

MA 605 NON-LINEAR DIFFERENTIAL EQUATIONS 3(3-0) F
Prerequisites: MA 509 or MA 512, MA 532

Phase-plane and phase-space concepts; existence and uniqueness theorems; continuity, analytic and differentiability properties of solution; properties of linear systems; stability in nonlinear systems; topological methods; perturbations of periodic solutions; asymptotic methods and resonance problems. Mr. Struble

MA 606 (ST 606, OR 606) MATHEMATICAL PROGRAMMING II 3(3-0) FS
(See Statistics, page 132.)

MA 607 (IE 607, OR 607) SELECTED TOPICS IN MATHEMATICAL PROGRAMMING 3(3-0) FS
(See Industrial Engineering, page 173.)

MA 608 INTEGRAL EQUATIONS

3(3-0) Alternate Sum.

Prerequisite: MA 509 or MA 512

Linear Volterra integral equations of the first and second kinds. Relationship to linear differential initial value problems. Special Volterra equations of the convolution type. Singular Volterra equations. Linear Fredholm integral equations of the first and second kind. Basic theory. Symmetric kernels. Hilbert-Schmidt theory (generalizations).
Mr. Winton

MA 611 COMPLEX VARIABLE THEORY AND APPLICATIONS I

3(3-0) F

Prerequisites: MA 509 or MA 512, together with either MA 513 or consent of instructor

Analytic functions, the Cauchy Riemann equations, and power series representations. Elementary conformal mappings, the group of Mobius transformations, elementary topology of plane and Riemann sphere; homology bases for plane regions. The integral theorem and formula of Cauchy. The calculus of residues.
Messrs. Bullock, Nickel, Sagan

MA 612 COMPLEX VARIABLE THEORY AND APPLICATIONS II

3(3-0) S

Prerequisites: MA 611

Analytic continuation. Entire and meromorphic functions. Picard's theorem, Ascoli's theorem and theory of normal families. The Riemann mapping theorem. Elementary theory of harmonic functions, and applications to potential theory.
Messrs. Bullock, Nickel, Sagan

MA 615 THEORY OF FUNCTIONS OF A REAL VARIABLE I

3(3-0) F

Prerequisites: MA 516, MA 517, or equivalent

Lebesgue measure on the real line and the Lebesgue integral; differentiation of monotone functions and of integrals; absolute continuity; topological, metric and L^p spaces.
Mr. Harrington

MA 616 THEORY OF FUNCTIONS OF A REAL VARIABLE II

3(3-0) S

Prerequisite: MA 615

General measure and integration theory in terms of measure spaces and measurable functions; the Lebesgue-Stielges integral; Banach spaces and linear functionals.
Mr. Harrington

MA 617 (ST 617) MEASURE THEORY AND ADVANCED PROBABILITY

3(3-0) F

(See Statistics, page 132.)

MA 618 (ST 618) MEASURE THEORY AND ADVANCED PROBABILITY

3(3-0) S

(See Statistics, page 132.)

MA 619 (ST 619) TOPICS IN ADVANCED PROBABILITY

3(3-0) F

(See Statistics, page 132.)

MA 621 INTRODUCTION TO MODERN ABSTRACT ALGEBRA

3(3-0) S

Prerequisite: MA 521 or equivalent

Elementary concepts of modules over a Euclidean ring. Elementary theories of indecomposable modules, injective modules and projective modules. Tensor products of modules, Hom and \otimes as functors, exact sequences and flat modules. Quasi-Frobenius rings, and modules over Quasi-Frobenius rings.
Mr. Koh

MA 622 LINEAR ALGEBRA

3(3-0) F

Prerequisite: MA 405 or equivalent

A study of vector spaces and their relation to the theory of matrices, the characteristic and minimal polynomials of a matrix, functions of matrices, theory

of elementary divisors, canonical forms of a matrix, application to systems of differential equations. Messrs. Nahikian, Park

MA 623 THEORY OF MATRICES AND APPLICATIONS 3(3-0) S
Prerequisite: MA 622

Matrix equations; linear operators in a Unitary Space and their associated matrices; complex symmetric, skew-symmetric and orthogonal matrices and canonical types to which they are orthogonally similar; pencils of matrices; matrix inversion techniques; applications in the areas of differential equations, statistics and Markov chain theory. Messrs. Nahikian, Park

MA 627 GENERAL TOPOLOGY 3(3-0) F
Prerequisite: MA 517 or consent of instructor

An introduction to point-set topology from a mature viewpoint. The axiomatic method in mathematics and the interactions between topology and the foundations of analysis are stressed. Topics covered include compactness, separation, connectedness and local connectedness. Mr. Chandler

MA 632 OPERATIONAL MATHEMATICS I 3(3-0) F
Prerequisite: MA 513 or MA 611

Laplace transform with theory and application to ordinary and partial differential equations arising from problems in engineering and physics. Messrs. Burniston, Harrington

MA 633 OPERATIONAL MATHEMATICS II 3(3-0) S
Prerequisite: MA 632

Extended development of the Laplace and Fourier transforms and their application to the solution of ordinary and partial differential equations, integral equations and difference equations; Z-transforms, other infinite and finite transforms and their applications. Messrs. Burniston, Harrington

MA 634 THEORY OF DISTRIBUTIONS 3(3-0) F
Prerequisite: MA 632 or consent of instructor

Basic definitions and properties of testing functions and distributions in one or more variables, convergence and calculus of distributions, test functions of rapid descent and distributions of slow growth, convolution, Fourier transforms, applications in the area of differential and difference equations, etc. Mr. Burniston

MA 635 NUMERICAL ANALYSIS III 3(3-0) S
Prerequisites: MA 512, MA 528
Corequisite: MA 405 or MA 622

The development of methods for the solution of selected problems involving matrices, integral rational equations, ordinary and partial differential equations. Particular attention is paid to the question of convergence and stability. Examples are solved on the IBM 360 system. Graduate Staff

MA 637 DIFFERENTIABLE MANIFOLDS 3(3-0) F
Prerequisites: MA 405, MA 521, MA 627 (corequisite) or consent of instructor

An introduction to the topology and geometry of differentiable manifolds. Multilinear algebra, exterior differential forms, differentiable manifolds, theory of connexions, Riemannian manifolds. Mr. Zund

MA 641 CALCULUS OF VARIATIONS AND THEORY OF OPTIMAL CONTROL I 3(3-0) F
Prerequisites: MA 512 or MA 509, MA 532

Normed linear function spaces and Frechet differential, theory of the first variation, theory of fields and Weierstrass' excess function, Hamilton-Jacobi theory and dynamic programming, terminal control problems and the maximum principle. Mr. Sagan

MA 642 CALCULUS OF VARIATIONS AND THEORY OF OPTIMAL CONTROL II 3(3-0) S
Prerequisite: MA 641

The homogeneous problem, the general control problem of Mayer, isoperimetric problems, theory of the second variation, existence of extrema, direct methods of the calculus of variations. Mr. Sagan

MA 647 FUNCTIONAL ANALYSIS I 3(3-0) F
Prerequisites: MA 615, MA 616

Complete, separable and compact metric spaces, completeness of L_p , Hilbert spaces, Riesz-Fischer Theorem, linear operators on normed linear spaces. Mr. Sagan

MA 648 FUNCTIONAL ANALYSIS II 3(3-0) S
Prerequisite: MA 647

Linear functionals on normed linear spaces, Hahn-Banach theorem, representation of linear functionals, completely continuous operators, self adjoint operators on a Hilbert space, inverse operators, spectral representation of self adjoint operators, approximate solution of linear operator equations. Mr. Sagan

MA 655 (PY 655) MATHEMATICS OF ASTRODYNAMICS I 3(3-0) F
Prerequisite: MA 532, MA 555, or consent of instructor

Lagrangian and Hamiltonian dynamics, Hamilton-Jacobi equation, two-body problem, canonical transformations, Delaunay variables, deduction of the method of variation of parameters from the canonical theory, theory of the gravitational potential, perturbation theories of Kazai and Brouwer-von Zeipel for orbits of artificial satellites. Mr. Danby

MA 656 (PY 656) MATHEMATICS OF ASTRODYNAMICS II 3(3-0) S
Prerequisite: MA 655

Theory of separable systems, including the spheroidal method for artificial satellites, the general and restricted three-body problems, Lagrange points and librational motion, lunar and planetary disturbing functions, lunar and planetary theories. Mr. Danby

MA 661 DIFFERENTIAL GEOMETRY AND TENSOR ANALYSIS I 3(3-0) F
Prerequisites: MA 508-509 or MA 511-512; MA 517 recommended or consent of instructor

Concepts of classical and modern differential geometry presented from the point of view of tensor analysis and differential forms. Topics to include: theory of curves, tensor analysis and differential forms, intrinsic and extrinsic geometry of surfaces, Riemannian geometry. Messrs. Levine, Zund

MA 662 DIFFERENTIAL GEOMETRY AND TENSOR ANALYSIS II 3(3-0)
Prerequisite: MA 661

Continuation of MA 661 Messrs. Levine, Zund

MA 681 SPECIAL TOPICS IN ANALYSIS 1-6

MA 683	SPECIAL TOPICS IN ALGEBRA	1-6
MA 685	SPECIAL TOPICS IN NUMERICAL ANALYSIS	1-6
MA 687	SPECIAL TOPICS IN GEOMETRY	1-6
MA 689	SPECIAL TOPICS IN APPLIED MATHEMATICS	1-6

The above courses, MA 681-MA 689, afford opportunities for graduate students to study advanced topics in mathematics under the direction of members of the graduate staff. These will, on occasion, consist of one of several areas such as, for example, advanced theory of partial differential equations, topology, mathematics of elasticity or of viscoelasticity, orbital mechanics, functional analysis, combinatorial analysis. Graduate Staff

MA 699 RESEARCH IN MATHEMATICS

Credits Arranged

Prerequisites: Graduate standing, consent of advisor

Individual research in the field of mathematics.

Graduate Staff

MATHEMATICS AND SCIENCE EDUCATION

GRADUATE FACULTY

Professor HERBERT E. SPEECE, *Head*

Associate Professor: NORMAN D. ANDERSON; *Assistant Professor:* HENRY A. SHANNON

The Department of Mathematics and Science Education offers graduate work leading to the degrees of Master of Science and Master of Education, with a major in mathematics education or science education. Each student's program is individually planned by a graduate committee and will reflect his undergraduate preparation, teaching experience and future professional plans. Areas of specialization include mathematics, biological science, earth science, chemistry and physics. A minimum of 36 semester hours is required, of which 60 percent must be in the area of subject matter specialization and 20 percent in professional education. Candidates for the Master of Education degree are required to submit a scholarly research paper; candidates for the Master of Science degree must conduct an investigation culminating in a thesis. The Master of Science degree also requires a reading knowledge of one foreign language.

Applicants must meet the admissions requirements of the Graduate School of North Carolina State University. Applicants must also have the approval of the Department of Mathematics and Science Education. To be admitted to the program without subject matter deficiencies, applicants must have completed a degree in which they have reached a level of undergraduate work closely approximating the following minimum: two years of English, one year of physics, one year of chemistry, one and one-half years in the historical-philosophical and psychology foundations of education. In addition to the above, those specializing in mathematics should have had three years of mathematics; those specializing in science should have had one year of biology, one and preferably two years of mathematics and two years of advanced work in one of the sciences.

A limited number of assistantships are available. For those desiring financial assistance, inquiries should be directed to the Department of Mathematics and Science Education.

FOR GRADUATES AND ADVANCED UNDERGRADUATES

ED 592 SPECIAL PROBLEMS IN MATHEMATICS TEACHING

3(0-3) FS

Prerequisite: ED 471 or equivalent

An investigation of current problems in mathematics teaching, with emphasis on the areas of curriculum, methodology, facilities, supervision and research. Specific problems will be studied in depth. Opportunities will be provided to initiate research studies.

Mr. Speece

ED 594 SPECIAL PROBLEMS IN SCIENCE TEACHING

3(0-3) FS

Prerequisite: ED 476 or equivalent

An investigation of current problems in science teaching with emphasis on areas of curriculum, methodology, facilities, supervision and research. Specific problems will be studied in depth. Opportunities will be provided to initiate research studies.

Graduate Staff

FOR GRADUATES ONLY

ED 690 SEMINAR IN MATHEMATICS EDUCATION

Maximum 2 FS

Prerequisite: Departmental major or consent of instructor

A critical analysis of issues, trends and recent developments in mathematics education.

Mr. Speece

ED 695 SEMINAR IN SCIENCE EDUCATION

Maximum 2 FS

Prerequisite: Departmental major or consent of instructor

A critical analysis of issues, trends and recent developments in science education.

Mr. Anderson

MECHANICAL AND AEROSPACE
ENGINEERING

GRADUATE FACULTY

Professor ROBERT W. TRUITT, *Head*

Professors: CARL F. ZOROWSKI, *Associate Head*, NORVAL W. CONNER, JESSE S. DOOLITTLE, *Graduate Administrator*, HASSAN A. HASSAN, RICHARD B. KNIGHT, M. NECATI OZISIK, ROBERT M. PINKERTON, FREDERICK O. SMETANA, JAMES E. SUNDERLAND, JAMES C. WILLIAMS, III, JAMES WOODBURN; *Adjunct Professors:* ROLF BUCHDAHL, ROBERT W. GRAHAM; *Associate Professors:* JOHN A. BAILEY, BERTRAM H. GARCIA, JR., FRANCIS J. HALE, FRANKLIN D. HART, JOHN N. PERKINS, JOHN K. WHITFIELD; *Adjunct Associate Professor:* E. CARSON YATES, JR.; *Assistant Professors:* ROLIN F. BARRETT, THOMAS B. LEDBETTER, JERRY S. LEE, CLIFFORD J. MOORE, JR., HUSEYIN C. TOPAKOGLU; *Adjunct Assistant Professor:* HAL L. MOSES

The Department of Mechanical and Aerospace Engineering offers graduate study leading to the Master of Mechanical Engineering, Master of Science and Doctor of Philosophy degrees. Entrance to the various programs in the department is normally based upon a pertinent, accredited baccalaureate degree.

At present the major emphases in graduate study are thermal sciences, including classical thermodynamics, statistical thermodynamics, heat transfer, transport phenomena, cryogenics and direct energy conversion; gas-dynamics, including dynamics of compressible fluids, dynamics of viscous fluids, aerothermochemistry, plasmadynamics and rarefied gasdynamics; mechanical sciences, including vibrations, acoustics, mechanical transients, design synthesis, analysis and optimization, materials processing, fiber mechanics; aerospace sciences, including aerodynamics, chemical and electrical propulsion and flight vehicle design.

The professional technological interests of the department are represented by graduate courses in air-conditioning design, lubrication, vacuum technology, cryogenics, inertial navigation, photoelasticity, experimental stress analysis and machine design.

Extensive laboratory facilities, including a helium cryostat, 48" oil diffusion pumps and large Roots blowers (45,000 CFM) are available for research and training in the area of plasmagasdynamics, rarefied gasdynamics, boundary layers and heat transfer, aerodynamics and cryogenics. A modern laboratory for the study of vibrations and acoustics is also available. Under development are extensive laboratory facilities in heat transfer, direct energy conversion, vehicle propulsion, materials processing and fiber mechanics. These experimental facilities coupled with availability of an IBM Model 360/75 computer provide the graduate students with outstanding research tools.

Graduate programs in mechanical and aerospace engineering normally include substantial work in mathematics and physics. Graduate students are also encouraged to include study in related engineering departments in their programs.

The fundamental objective of graduate study in this field is to prepare the student for leadership in the various areas of research, teaching and design. The graduate student is placed in close association with members of the graduate faculty who conduct individual research. Participation in a research project as a research assistant or employment as a teaching assistant is regarded as significant experience during residence.

FOR ADVANCED UNDERGRADUATES

MAE 401 ENERGY CONVERSION

3(3-0) FS

Prerequisite: MAE 302

A course on the conversion of energy for engineering purposes based upon the fundamentals leading to engineering decisions in the arrangement and selection of energy conversion equipment. The conventional type of plant for energy conversion and the unconventional types, in particular, direct energy conversion and the feasibility of such plants. Factors which affect the cost of power and elements entering into the problem of monetary rates.

MAE 402 HEAT AND MASS TRANSFER

3(3-0) FS

Prerequisites: MA 301, MAE 302

A study of the fundamental relationships of steady and transient heat transfer of conduction, convection, radiation and during changes of phase; mass transfer by diffusion and convection; simultaneous mass and heat transfer.

MAE 403 AIR CONDITIONING**3(3-0) F****Prerequisite:** MAE 302

A fundamental study of summer and winter air conditioning including temperature, humidity, air velocity and distribution.

MAE 404 REFRIGERATION**3(3-0) S****Prerequisite:** MAE 302

A thermodynamic analysis of the simple, compound, centrifugal and multiple effect compression systems, the steam jet system and the absorption system of refrigeration.

MAE 405 MECHANICAL ENGINEERING LABORATORY III**1(0-3) F****Prerequisite:** MAE 306

The selection of appropriate instrumentation and the experimental analysis of small, predetermined engineering systems designed for flexibility and wide variation of parameters. Systems cover the gamut of mechanical engineering activity with emphasis on analysis of systems rather than characteristics of particular systems.

MAE 406 MECHANICAL ENGINEERING LABORATORY IV**1(0-3) S****Prerequisite:** MAE 405

Individual or small-group investigation of an original problem under the supervision of a faculty member with an interest in the problem area. The investigation may be experimental, analytical or both. Emphasis is placed on the philosophy and methodology of engineering research and on individual thinking and effort.

MAE 410 JET PROPULSION**3(3-0) S****Prerequisites:** MAE 302, MAE 352 or EM 303

Application of fundamental principles of thermodynamics and the mechanics of a compressible fluid to the processes of jet-propulsion and the turbo-propeller aircraft; the effect of performance of components on performance of engines; analysis of engine performance parameters.

MAE 411, 412 MECHANICAL DESIGN I, II**3(3-0) FS****Prerequisites:** EM 301, MAE 315, MIM 201

Application of the engineering and material sciences to the analysis and design of mechanical components and systems. Consideration and utilization of the design process including problem definition, solution synthesis, design analysis, optimization and phototype evaluation through design project activity.

MAE 421 AEROSPACE PROPULSION SYSTEMS**3(3-0) F****Prerequisite:** MAE 353

A study of propulsion systems and their relation to the various flight regimes and space missions. The principles of thrust generation, the control and the performance of various propulsion systems will be considered.

MAE 422 DIRECT ENERGY CONVERSION DEVICES**3(3-0) FS****Prerequisites:** MAE 301, EE 202 or EE 332

Theory and application of direct energy conversion devices, thermoelectric and thermionic converters, solar and fuel cells, magnetohydrodynamic power generators, thermodynamic analysis, device characteristics and design considerations.

MAE 431 THERMODYNAMICS OF FLUID FLOW 3(3-0) FS
Prerequisites: MA 301; MAE 302, EM 303 or MAE 352

The fundamental dynamics and thermodynamic principles governing the flow of gases are presented from both theoretical and experimental viewpoints. Mathematical relations are closely correlated with physical phenomena to emphasize the complimentary nature of theory and experiment.

MAE 432 BOUNDARY LAYER THEORY AND HEAT TRANSFER 3(3-0) FS
Prerequisites: C or better in MAE 352; MA 401 or MA 511

The course is intended to give the student both a physical and mathematical understanding of the problems of skin friction and heat transfer in present-day aerospace engineering.

MAE 435 PRINCIPLES OF AUTOMATIC CONTROL 3(3-0) FS
Prerequisite: MA 301

Study of linear feedback control systems using transfer functions. Transient and steady-state responses. Stability analysis using root-locus, frequency response (Bode plots) and Nyquist techniques. Active and passive compensation methods. Preliminary design and analysis of typical mechanical and aerospace automatic control systems.

MAE 447 PERFORMANCE, STABILITY AND CONTROL OF FLIGHT VEHICLES 3(3-0) F
Prerequisites: C or better in MAE 352; MA 401 or MA 511

A study of aerodynamic and inertial factors and how they influence the motion of flight vehicles and their performance. The transfer function approach is emphasized in the analysis of flight vehicle motion.

MAE 450 INTRODUCTION TO VACUUM TECHNOLOGY 3(2-3) FS
Prerequisite: MAE 301

An introduction to the physical phenomena and apparatus associated with vacuum technology and rarefied gas research. Instruction in the use of vacuum laboratory equipment and demonstration of basic rarefied gas phenomena will be emphasized.

MAE 461 AEROSPACE TECHNOLOGY 3(3-0) S
Corequisite: MAE 353

An introduction to the principles of flight in and beyond the atmosphere. Includes the elements of aerodynamics of flight, the reentry problem, flight dynamics, guidance and control, power generation in space, manned and unmanned space flight and life support systems.

MAE 465, 466 AEROSPACE ENGINEERING LABORATORY 1(0-3) FS
Prerequisites: MAE 306, MAE 352

Laboratory experience in wind tunnel experimentation, structural testing, environmental testing and instrumentation for flight in and beyond the atmosphere.

MAE 468 SPACECRAFT STRUCTURES 3(3-0) F
Prerequisite: MAE 369

Basic techniques and procedures in the analysis of stresses and strains caused by the extreme heating of reentry space vehicles as well as the dynamic and impulsive loads occurring during the launching and loading period of flight will be considered and the resulting effects on the vehicle structure will be studied.

MAE 481 FLIGHT VEHICAL DESIGN**5(3-6) S****Prerequisites:** EE 202, MAE 421, MAE 447, MAE 461, MAE 468

Integration of previous aerodynamic, heat transfer, materials, structures and dynamical theory in the design of typical air-supported space vehicles and their subsystems.

MAE 495 TECHNICAL SEMINAR**1(1-0) FS****Prerequisite:** Senior standing

Meetings once a week for the delivery and discussion of student papers on topics of current interest in mechanical engineering.

FOR GRADUATES AND ADVANCED UNDERGRADUATES**MAE 501 STEAM AND GAS TURBINES****3(3-0) FS****Prerequisites:** MAE 302, EM 303 or MAE 352

Fundamental analysis of the theory and design of turbomachinery flow passages; control and performance of turbomachinery; gas-turbine engine processes.

Mr. Doolittle**MAE 507, 508 INTERNAL COMBUSTION ENGINE FUNDAMENTALS****3(3-0) FS****Prerequisite:** MAE 302

The fundamentals common to internal combustion engine cycles of operation. The Otto engine: carburetion, fuel distribution, flame propagation, normal and knocking combustion, throttling, pumping, valve and spark timing, and altitude effects; the Diesel engine: injection and spray formation, fuel rating, auto-ignition, penetration, diesel knock, combustion, pre-combustion and scavenging as applied to reciprocating and rotary engines.

Mr. Ledbetter**MAE 513 VIBRATION AND NOISE CONTROL****3(2-3) F****Prerequisite:** MAE 315 or MAE 369

This course will be devoted to a study of the nature and origin of vibration and noise in mechanical systems and design for their control. Considerations will include source reduction, isolation, transmission, damping and acoustic shielding techniques, through classroom discussions and laboratory demonstrations.

Mr. Hart**MAE 515 EXPERIMENTAL STRESS ANALYSIS****3(2-3) F****Prerequisite:** MAE 315

Theoretical and experimental techniques of strain and stress analysis with emphasis on electrical strain gages and instrumentation, brittle coatings, grid methods and an introduction to photoelasticity. Laboratory includes an investigation and complete report of a problem chosen by the student under the guidance of the instructor.

Mr. Whitfield**MAE 516 PHOTOELASTICITY****3(2-3) S****Prerequisite:** MAE 411

Theory and experimental techniques of two- and three-dimensional photoelasticity including photoelastic coatings, photoplasticity and application of photoelastic methods to the solution of mechanical design problems. Laboratory includes an investigation and complete report of a problem chosen by the student under the guidance of the instructor.

Mr. Whitfield

MAE 517 LUBRICATION 3(2-3) S
Prerequisite: EM 303

The theory of hydrodynamic lubrication; Reynold's equation, the Sommerfield integration, effect of variable lubricant properties and energy equation for temperature rise. Properties of lubricants. Application to design of bearings. Boundary lubrication. Mr. Barrett

MAE 521 AEROTHERMODYNAMICS 3(3-0) F or S
Prerequisites: MAE 301; MAE 352 or EM 303

Review of basic thermodynamics pertinent to gasdynamics. Detailed development of the general equations governing gas motion in both differential and integral form. Simplification of the equations to those for specialized flow regimes. Similarity parameters. Applications to simpler problems in various flow regimes. Mr. Perkins

MAE 531 PLASMAGASDYNAMICS I 3(3-0) FS
Prerequisites: MAE 533, PY 414

Study of basic laws governing plasma motion for dense and rarefied plasmas, hydromagnetic shocks, plasma waves and instabilities, simple engineering applications. Mr. Hassan

MAE 532 PLASMAGASDYNAMICS II 3(3-0) FS
Prerequisite: MAE 531

Quantum statistics and ionization phenomena. Charged particles interactions. Transport properties in the presence of electric and magnetic fields and non-equilibrium ionization. Graduate Staff

MAE 541, 542 AERODYNAMIC HEATING 3(3-0) FS
Prerequisites: MA 511, MAE 521

A detailed study of the latest theoretical and experimental findings of the compressible laminar and turbulent boundary layers with special attention to the aerodynamic heating problem; application of theory in the analysis and design of aerospace hardware. Mr. Williams

MAE 545, 546 PROJECT WORK IN MECHANICAL ENGINEERING I, II 2(0-4) FS

Individual or small-group investigation of a problem stemming from a mutual student-faculty interest. Emphasis is placed on providing a situation for exploiting student curiosity. Graduate Staff

MAE 550 CRYOGENICS I 3(3-0) FS
Prerequisite: MAE 402 or MAE 432

A study of the thermodynamic processes required to produce cryogenic fluids. Properties of materials at cryogenic temperatures. Insulation of cryogenic vessels and lines. Design of cryogenic systems. Mr. Smetana

MAE 554 ADVANCED AERODYNAMIC THEORY 3(3-0) S
Prerequisite: MAE 352

Development of fundamental aerodynamic theory. Emphasis upon mathematical analysis and derivation of equations of motion, airfoil theory and comparison with experimental results. Introduction to supersonic flow theory. Mr. Pinkerton

MAE 562 ADVANCED AIRCRAFT STRUCTURES

3(3-0) S

Prerequisite: MAE 468

Development of methods of stress analysis for aircraft structures, special problems in structural design, stiffened panels, rigid frames, indeterminate structures, general relaxation theory.

Mr. Topakoglu

MAE 571 INERTIAL GUIDANCE, DESIGN AND ANALYSIS

3(3-0) S

Prerequisites: MA 401, MAE 435 or MAE 447

Engineering design and performance analysis of inertial guidance components, subsystems and systems. Development of transfer functions and application of linear system techniques to determine stability, transient response and steady-state errors of gyros, accelerometers, stable platforms and initial alignment subsystems. Error analysis and its significance. Preliminary design and analysis of typical inertial guidance systems for flight and marine vehicles.

Mr. Hale

MAE 581, 582 HYPERSONIC AERODYNAMICS

3(3-0) FS

Prerequisites: MA 512, MAE 521

A detailed study of the latest theoretical and experimental findings in hypersonic aerodynamics.

Mr. Truitt

MAE 593 SPECIAL TOPICS IN MECHANICAL ENGINEERING

3(3-0) F or S

Prerequisite: Advanced undergraduate or graduate standing

Faculty and student discussions of special topics in mechanical engineering.

Graduate Staff

FOR GRADUATES ONLY**MAE 601 ADVANCED ENGINEERING THERMODYNAMICS**

3(3-0) F

Prerequisites: MAE 302; MA 401 or MA 511

Thermodynamics of a general reactive system; conservation of energy and the principles of increase of entropy; the fundamental relation of thermodynamics; Legendre transformations; equilibrium and stability criteria in different representations; general relations; chemical thermodynamics; multireaction system; ionization; irreversible thermodynamics; the Onsager relation; applications to thermoelectric, thermomagnetic and diffusional processes.

Mr. Lee

MAE 602 STATISTICAL THERMODYNAMICS

3(3-0) S

Prerequisite: MAE 601

Fundamental principles of kinetic theory, quantum mechanics, statistical mechanics and irreversible phenomena with particular reference to thermodynamics systems and processes. The conclusions of the classical thermodynamics are analyzed and established from the microscopic viewpoint.

Mr. Lee

MAE 603 ADVANCED POWER PLANTS

3(3-0) F

Prerequisite: MAE 401

A critical analysis of the energy balance of thermal power plants, thermodynamics and economic evaluation of alternate schemes of development; study of recent developments in the production of power.

Mr. Doolittle

MAE 605 AEROTHERMOCHEMISTRY

3(3-0) S

Prerequisites: MA 511; MAE 601 or equivalent

A generalized treatment of combustion thermodynamics including derivation of thermodynamic quantities by the method of Jacobians, criteria for thermodynamic equilibrium, computation of equilibrium composition and adiabatic flame tempera-

ture. Introduction to classical chemical kinetics. Conservation equations for a reacting system, detonation and deflagration. Theories of flame propagation, flame stabilization and turbulent combustion. Mr. Perkins

MAE 606 ADVANCED GAS DYNAMICS 3(3-0) S
Prerequisites: MA 511, MAE 521, MAE 601

The general conservation equations of gas dynamics from a differential and integral point of view. Hyperbolic compressible flow equations, unsteady one-dimensional flows, the nonlinear problem of shock wave formation, isentropic flow, flow in nozzles and jets, turbulent flow. Mr. Smetana

MAE 608 ADVANCED HEAT TRANSFER I 3(3-0) F
Prerequisites: MA 512, MAE 402

A generalized treatment of the methods of solution of transient and steady heat conduction in finite and infinite regions involving internal heat generation. Approximate methods and similarity transformation in the solution of heat conduction problems involving change of phase, variable thermal properties and nonlinear thermal radiation boundary conditions. Heat conduction in multi-layer regions and in anisotropic solids. Solutions with numerical methods.

Mr. Ozisik

MAE 609 ADVANCED HEAT TRANSFER II 3(3-0) S
Prerequisite: MAE 608

Advanced topics in steady and transient natural and forced convection heat transfer for laminar and turbulent flow of incompressible fluid through conduits and over bodies. Problems involving variable properties and interaction with thermal radiation. Mass transfer in laminar and turbulent flow; simultaneous heat and mass transfer.

Mr. Ozisik

MAE 610 ADVANCED TOPICS IN HEAT TRANSFER 3(3-0) S
Prerequisite: MAE 609

This course constitutes a study of recent developments in heat transfer and related areas. It is anticipated that the course content will change from semester to semester.

Mr. Ozisik

MAE 611, 612 ADVANCED MACHINE DESIGN I, II 3(3-0) FS
Prerequisite: MAE 412

An advanced integrated treatment of stress analysis and materials engineering devoted to current rational methods of analysis and design applicable to mechanical components. Primary attention placed on the determination and prediction of strength, life and deformation characteristics of machine components as dictated by performance requirements.

Messrs. Garcia, Zorowski

MAE 613 MECHANICS OF MACHINERY 3(3-0) F
Prerequisites: MAE 315; MA 512 or MA 402

Advanced applications of dynamics to the design and response analysis of dynamic behavior of machines and mechanical devices. Emphasis on developing competence in transforming real problems in dynamics into appropriate mathematical models whose analysis permits performance predictions of engineering value.

Messrs. Hart, Whitfield

MAE 614 MECHANICAL TRANSIENTS AND MACHINE VIBRATIONS 3(3-0) S
Prerequisites: MAE 315 or EM 545; MA 512 or MA 402

A study of the forces and motions produced in mechanical systems by periodic

and transient inputs including shock and impact loading. Particular attention devoted to the application of the principles of vibration theory to problems encountered in mechanical design.

Messrs. Hart, Whitfield

MAE 615 AEROELASTICITY I

3(3-0) F

Prerequisites: MA 511; MAE 411 or MAE 468; MAE 521

Deformations of aerostructures under static and dynamic loads, natural mode shapes and frequencies; two- and three-dimensional incompressible flow, wings and bodies in unsteady flow; static aeroelastic phenomena.

Mr. Topakoglu

MAE 617 MECHANICAL SYSTEM DESIGN ANALYSIS

3(3-0) F

Prerequisites: MAE 611, MAE 613

Lecture and project activity devoted to development of the ability to apply knowledge and experience in performing comprehensive design analysis of complete mechanical systems. Areas of interest to include critical problem recognition, system modeling, performance determination, and optimization and reliability evaluation.

Mr. Zorowski

MAE 618 MECHANICAL SYSTEM DESIGN SYNTHESIS

3(3-0) S

Prerequisite: MAE 617

Application of the basic philosophy and methodology of the complete design process to advanced mechanical system design. Individual and group experience in the conception, synthesis, analysis, optimization and implementation phases of feasibility, preliminary and final design studies provided by means of comprehensive system design projects.

Mr. Zorowski

MAE 619 RANDOM VIBRATION

3(3-0) F or S

Prerequisite: MAE 614

Mathematical description of stochastic processes. The stationary and ergodic assumptions and response analysis of mechanical systems to random excitation. Simulation of and failure due to random environments.

Mr. Hart

MAE 625, 626 DIRECT ENERGY CONVERSION

3(3-0) FS

Prerequisite: MAE 601

An engineering study of the modern developments in the field of conversion of heat to power in order to meet new technology demands. Thermoelectric, thermomagnetic, thermionic, photovoltaic and magnetohydrodynamic effects and their utilization for energy conversion purposes, static and dynamic response, limitations imposed by the first and the second laws of thermodynamics. Energy and entropy balances, irreversible sources; inherent losses, cascading, design procedures, experimental studies to determine the response and efficiency of various systems.

Mr. Lee

MAE 631 APPLICATIONS OF ULTRASONICS TO ENGINEERING RESEARCH

3(3-0) F

Prerequisites: EE 332, MA 511

The technique and theory of propagation of ultrasonics in liquids, gases and solids. Development of ultrasonic transducers, the elastic piezoelectric and dielectric relationships. Ultrasonic applications of asdic or sonar cavitation, emulsification, soldering, welding and acoustic properties of gases, liquids and solids.

Mr. Woodburn

MAE 651 PRINCIPLES OF FLUID MOTION

3(3-0) F

Prerequisite: MAE 554

Coresquisite: MA 511

Fundamental principles of fluid dynamics. Mathematical methods of analysis

are emphasized. Potential flow theory development with introduction to the effects of viscosity and compressibility. Two-dimensional and three-dimensional phenomena are considered. Mr. Pinkerton

MAE 652 DYNAMICS OF COMPRESSIBLE FLOW 3(3-0) F
Prerequisites: MA 511, MAE 521

Properties of compressible fluids, equation of motion in one-dimensional motion, channel flows, shock wave theory, methods of observation and flows at transonic speeds. Mr. Pinkerton

MAE 653 SUPERSONIC AERODYNAMICS 3(3-0) S
Prerequisite: MAE 521

Equations of motion in supersonic flow, Prandtl-Meyer turns, method of characteristics, hodograph plane, supersonic wind tunnels, supersonic airfoil theory and boundary layer shock interaction. Mr. Perkins

MAE 654 DYNAMICS OF VISCOUS FLUIDS I 3(3-0) F
Prerequisite: MAE 521

Exact solutions to the Navier-Stokes Equations. Approximate solutions for low Reynolds numbers. Approximate solutions for high Reynolds numbers—incompressible boundary theory. Laminar and turbulent boundary layers in theory and experiment. Flows separation. Mr. Williams

MAE 655 DYNAMICS OF VISCOUS FLUIDS II 3(3-0) S
Prerequisite: MAE 654

A continuation of MAE 654. Compressible laminar and turbulent boundary layers. Laminar and turbulent jets. The stability of laminar boundary layers with respect to small disturbances, transition from laminar to turbulent flow. Mr. Williams

MAE 657 MEASUREMENT IN RAREFIED GAS STREAMS 3(3-0) F
Prerequisite: MAE 602

A study of the basis for measurement of flow properties in rarefied gas streams. Included will be ionization gauges, hot wire anemometers and temperature probes, pitot and static tubes, Langmuir probes, electron scattering and electron beam density gauges. Mr. Smetana

MAE 658, 659 MOLECULAR GAS DYNAMICS 3(3-0) FS
Prerequisites: MAE 521, MAE 602

Statistical mechanics as applied to the derivation of the equations of gas-dynamics from the microscopic viewpoint. Energy levels of atoms and molecules and their relation to equilibrium thermodynamic concepts, in particular, specific heats. Approximate solutions of the Boltzmann Equation. Treatments of viscosity, heat conduction and electrical conductivity. Collision processes. High-temperature behavior of multispecies gas mixtures. Mr. Williams

MAE 661, 662 AEROSPACE ENERGY SYSTEMS 3(3-0) FS
Prerequisites: MA 512, MAE 521, PY 407, or equivalent

A study of energy systems appropriate to the varied requirements of space operations. Includes analysis of chemical, nuclear and solar energy sources and the theory of their adaptation to operational requirements for propulsion and auxiliary power, cooling requirements, coolants and materials. Mr. Truitt

MAE 671, 672 ADVANCED AIR CONDITIONING DESIGN I, II 3(3-0) FS
Prerequisites: MAE 403, MAE 404

The design of heating and air-conditioning systems; the preparation of specifications and performance tests on heating and air-conditioning equipment.

Mr. Knight

MAE 674, 675 ADVANCED SPACECRAFT DESIGN 3(3-0) FS
Prerequisites: MAE 542, MAE 582

Analysis and design of spacecraft including system design criteria, acceleration tolerance, entry environment, thermal requirements, criteria for configuration design, aerodynamic design, heating rates, thermostructural design, boost phase, de-orbit, entry corridor, lift modulation, rolling entry, glide phase, maneuvering and landing, stability and control, thermal protection system, materials, instrumentation and life-support systems.

Mr. Truitt

MAE 681 INTRODUCTION TO ROCKET PROPULSION 3(3-0) F
Prerequisite: MAE 601

Review of the exterior ballistics and performance of rocket-propelled vehicles. Thermodynamics of real gases at high temperature. Nonequilibrium flow in rocket nozzles.

Mr. Perkins

MAE 682 SOLID PROPELLANT ROCKETS 3(3-0) S
Prerequisite: MAE 681

A study of the design and performance of solid-propellant rockets; properties and burning characteristics of solid propellants. Internal ballistics of solid-propellant rockets. Design and design optimization. Combustion instabilities.

Mr. Hassan

MAE 683 LIQUID PROPELLANT ROCKETS 3(3-0) S
Prerequisite: MAE 681

The study and design of liquid-propellant rockets. Combustion of liquid fuels. Thrust chamber, propellant supply and injection system. Cooling of rocket motors. Low- and high-frequency instability in liquid rocket motors. Scaling laws.

Mr. Hassan

MAE 684 ION PROPULSION 3(3-0) F or S
Prerequisite: MAE 531

Study and design of ion motors, power sources and converters, missions for ion-propelled vehicles.

Mr. Hassan

MAE 693 ADVANCED TOPICS IN MECHANICAL ENGINEERING 1-6 F or S
Prerequisite: Graduate standing

Faculty and graduate student discussions of advanced topics in contemporary mechanical engineering.

Graduate Staff

MAE 695 MECHANICAL ENGINEERING SEMINAR 1(1-0) F or S
 Faculty and graduate student discussions centered around current research problems and advanced engineering theories.

Graduate Staff

MAE 699 MECHANICAL ENGINEERING RESEARCH Credits Arranged
Prerequisites: Graduate standing in mechanical engineering, consent of advisor
 Individual research in the field of mechanical engineering.

Graduate Staff

METALLURGICAL ENGINEERING

(For a listing of graduate faculty and departmental information see Mineral Industries, page 199.)

FOR ADVANCED UNDERGRADUATES

MIM 401, 402 METALLURGICAL OPERATIONS I, II 4(3-3) FS
Prerequisite: MIM 332

A systematized treatment of the fundamental operations involved in the production and fabrication of metals and alloys. Part I deals primarily with procedures and operations employed in chemical or extractive metallurgy. Part II covers the operations of physical and mechanical metallurgy.

MIM 421, 422 METALLURGY I, II 2(2-0) FS
Prerequisite: CH 103

The constitution, structure and properties of engineering ferrous and non-ferrous metals and alloys; influences of mechanical working and heat treatment; physical testing, corrosion and its prevention.

MIM 423 METALLURGICAL LABORATORY 1(0-3) FS
Corequisite: MIM 421 or MIM 422

Laboratory work to accompany Metallurgy I, II.

MIM 431, 432 METALLOGRAPHY I, II 3(2-3) FS
Prerequisite: MIM 332

An intensive study of the principles and techniques for examination and correlation of the structure, constitution and properties of metals and alloys.

MIM 491, 492 METALLURGICAL ENGINEERING SEMINAR 1(1-0) FS
Prerequisite: Senior standing in metallurgical engineering

Reports and discussion of special topics in metallurgical engineering and related subjects.

MIM 495, 496 EXPERIMENTAL ENGINEERING I, II 3(1-6) FS
Prerequisite: MIM 422 or consent of instructor

Advanced engineering principles applied to a specific project in metallurgy, metallography or other experimental work.

FOR GRADUATES AND ADVANCED UNDERGRADUATES

MIM 521, 522 ADVANCED PHYSICAL METALLURGY I, II 3(3-0) FS
Prerequisite: MIM 422 or MIM 432

Theories concerning behavior and control of engineering alloys, reaction rates in the solid state, and alloy influences; current heat treating practices; surface treatments; behavior of metals at high and low temperatures; special-purpose alloys; powder metallurgy; review of modern equipment and methods for the study of metals.

Mr. Stadelmaier

MIM 523, 524 METALLURGICAL FACTORS IN DESIGN 3(3-0) FS
Prerequisite: MIM 422

A study of the metallurgical factors that must be considered in using metals in design.

Mr. Austin

MIM 541, 542 PRINCIPLES OF CORROSION I, II**3(2-3) FS****Prerequisite:** MIM 422

The fundamentals of metallic corrosion and passivity. The electrochemical nature of corrosive attack, basic forms of corrosion, corrosion rate factors, methods of corrosion protection. Laboratory work included.

Mr. Austin**MIM 561 ADVANCED STRUCTURE AND PROPERTIES OF MATERIALS****3(2-3) F****Prerequisite:** MIM 422

A systematic treatment of the fundamental physico-chemical principles governing the constitution of both metallic and ceramic materials. Correlation of these principles with physical, mechanical and chemical properties of materials. Particular emphasis is placed upon materials of construction for nuclear reactors.

Mr. Austin**MIM 562 (NE 562) MATERIALS PROBLEMS IN NUCLEAR ENGINEERING 3(3-0) S****Prerequisites:** MIM 422, PY 410 or equivalent

Those reactor component design considerations determined by materials properties as well as by nuclear function will be discussed. Emphasis will be placed on radiation metallurgical processes in materials pertinent to fast reactors for either terrestrial or space applications.

MIM 595, 596 ADVANCED METALLURGICAL EXPERIMENTS I, II**3(1-6) FS****Prerequisite:** MIM 422 or consent of instructor

Advanced engineering principles applied to a specific experimental project dealing with metallurgy or metallography. A seminar period is provided and a written report is required.

Graduate Staff**FOR GRADUATES ONLY****MIM 651, 652 THEORY AND STRUCTURE OF METALS****3(3-0) FS****Prerequisite:** MIM 522

An advanced interpretation of the development of theories of the metallic state with emphasis on modern physical concepts. Topics include theory of crystallinity, bonding forces, stability of metallic structures, diffusion and dislocation theory.

Mr. Stadelmaier**MIM 691, 692 SPECIAL TOPICS IN METALLURGICAL ENGINEERING****3(3-0) FS****Prerequisite:** Graduate standing

Special studies of advanced topics in metallurgical engineering.

Graduate Staff**MIM 699 METALLURGICAL ENGINEERING RESEARCH****Credits Arranged**

Independent investigation of an appropriate problem in metallurgical engineering. A report on this investigation is required as a graduate thesis. Graduate Staff

MICROBIOLOGY**GRADUATE FACULTY***Professor* **JAMES B. EVANS, Head**

Associate Professors: **WALTER J. DOBROGOSZ, GERALD H. ELKAN, PAT B. HAMILTON, JEROME J. PERRY; Assistant Professor:** **HARISH C. MINOCHA**

ASSOCIATE MEMBERS OF THE DEPARTMENT

Professors: WILLIAM V. BARTHOLOMEW, JOHN L. ETHELLES, JAMES G. LECCE, MARVIN L. SPECK; *Associate Professors:* FRANK B. ARMSTRONG, JOHN J. MCNEILL

The Department of Microbiology offers programs leading to the Master of Science and Doctor of Philosophy degrees.

Students applying for admission to the programs need not have had any formal training in microbiology. Applicants should have a bachelor's degree in one of the biological or physical sciences with at least two years of biology (preferably including a semester of microbiology), two years of chemistry (including a year of organic), two years of math (including a year of calculus), a year of physics and two years of a foreign language. Any deficiencies may be made up while in graduate school but will not be counted as credit toward a graduate degree.

There are no specific departmental requirements regarding courses of study. Each program is tailored for the individual student by his graduate advisory committee. There is a core of basic courses in microbiology that will be on the programs of most graduate students. However, at least half of the courses in most programs will be basic courses in related areas such as biochemistry, chemistry, genetics and cell biology.

All graduate programs in microbiology require a research thesis on some basic aspect of the science. At least one semester of half-time teaching experience is required of all Ph.D. candidates. As a general rule the M.S. program requires two full years beyond the B.S. level and the Ph.D. program requires two or three years beyond the M.S. level.

FOR ADVANCED UNDERGRADUATES

MB 401 GENERAL MICROBIOLOGY

3(3-0) S

Prerequisites: BS 100, CH 223 or CH 220

A rigorous introduction to the basic principles and concepts of modern microbiology. This course is recommended for students in the biological sciences and agricultural sciences curricula and for all students who plan to take further courses in microbiology. All students in this course should take the laboratory course MB 402 concurrently.

Mr. Elkan

MB 402 GENERAL MICROBIOLOGY LAB

1(0-2) S

Prerequisites: MB 401 (concurrently) or MB 301, CH 223 or CH 220

An introduction to the basic laboratory techniques of microbiology. This will include methods of isolating, culturing, staining, quantitating and characterizing pure cultures of microorganisms. There will be one two-hour formal lab period and students will be expected to come in briefly at other times to make observations.

Mr. Elkan

FOR GRADUATES AND ADVANCED UNDERGRADUATES

MB 501 ADVANCED MICROBIOLOGY

4(3-2) F

Prerequisite: MB 402

A study in some depth of microbial structure and function, host-parasite relationships, microbial ecology and characterization of important groups of microorganisms.

Messrs. Lecce, Perry

MB 505 (FS 505) FOOD MICROBIOLOGY (See Food Science, page 140.)	3(2-3)
MB 506 (FS 506) ADVANCED FOOD MICROBIOLOGY (See Food Science, page 140.)	3(0-9) F
MB 514 MICROBIAL METABOLISM Prerequisites: MB 402, BCH 351 or BCH 551 A study of the physiology and metabolism of microorganisms and their regulatory mechanisms. Messrs. Dobrogosz, McNeill	4(3-2) S
MB 532 (SSC 532) SOIL MICROBIOLOGY (See Soil Science, page 242.)	3(3-0) S
MB 555 (ZO 555) PROTOZOOLOGY (See Zoology, page 257.)	4(2-6) F
MB 561 (BCH 561, GN 561) BIOCHEMICAL AND MICROBIAL GENETICS (See Genetics, page 151.)	3(3-0) F
MB 570 (CE 570) SANITARY MICROBIOLOGY (See Civil Engineering, page 91.)	3(2-3) S
MB 571 VIROLOGY Prerequisites: BCH 551, MB 401 An introduction to the fundamental aspects of virus-cell interactions. These include virus attachment and penetration, intracellular virus replication, metabolic changes occurring in cells as a result of virus infection and virus-induced cellular transformations. Mr. Minocha	3(3-0) S
MB 574 (BO 574) PHYCOLOGY (See Botany, page 72.)	3(1-4) S
MB 575 (BO 575, PP 575) THE FUNGI (See Botany, page 72.)	4(3-3) S
MB 590 TOPICAL PROBLEMS Prerequisite: Graduate standing or consent of instructor	Credits Arranged FS Graduate Staff

FOR GRADUATES ONLY

MB 632 (SSC 632) ECOLOGY AND FUNCTIONS OF SOIL MICROORGANISMS (See Soil Science, page 243.)	3(3-0) S
MB 690 MICROBIOLOGY SEMINAR	1(1-0) FS Graduate Staff
MB 692 SPECIAL PROBLEMS IN MICROBIOLOGY	Credits Arranged FS Graduate Staff
MB 699 MICROBIOLOGY RESEARCH	Credits Arranged FS Graduate Staff

MINERAL INDUSTRIES

GRADUATE FACULTY

Professor WILLIAM W. AUSTIN, *Head*

Professors: JOE R. BEELER, WILLIAM C. BELL, WILLIAM W. KRIEDEL, JAMES K. MAGOR, HAYNE PALMOUR, III, HANS H. STADELMAIER, ROBERT F. STOOPS; *Adjunct Professor:* HENRY M. DAVIS; *Visiting Professor:* JOACHIM-DIETRICH SCHOBEL; *Associate Professors:* JOHN V. HAMME, CHARLES R. MANNING, JR.

The Department of Mineral Industries offers graduate programs leading to the degrees of Master of Science in ceramic engineering and metallurgical engineering, and to the Doctor of Philosophy degree with the major in ceramic engineering. Certain graduate courses are also offered for the benefit of students majoring in other areas who may be interested in pursuing advanced work in the mineral industries fields.

Financial assistance is available to qualified graduate students in the Department of Mineral Industries. Graduate assistantships permit half-time studies in either ceramic engineering or metallurgical engineering, and half-time to be devoted to teaching or research. Also, certain sponsored fellowships and traineeships that permit full time to be devoted to graduate studies are available on a competitive basis. Applications should be made to the department.

CERAMIC ENGINEERING

The unique characteristics of ceramics qualify them for many advanced engineering applications in space, nuclear and industrial technologies. Rapid expansion of this important materials discipline presents challenging opportunities for engineering and research. Advanced study is fast becoming a prerequisite for careers in significant growth areas. North Carolina State University has been actively engaged in post-graduate teaching and research for more than three decades and, since 1950, has been the only institution in the Southeast offering the Doctor of Philosophy degree in ceramic engineering. Recruitment for stimulating employment by nationally prominent industrial, educational and governmental organizations consistently outstrips available graduate degree recipients.

The graduate program is predicated upon acquisition of fundamental understanding of the combined influence of material chemistry, defect structure in the solid state, process selection and kinetics, microstructure, environment and service conditions upon the ultimate performance of ceramic products. The research interests of the graduate faculty currently encompass a broad spectrum of the ceramic field. Included are materials synthesis, processing kinetics, phase relationships, constitution and structure, mechanical and dielectric properties of crystalline and vitreous materials, and design, development and applications of ceramics and ceramic composites.

Well-equipped laboratories for graduate instruction and research are in active use and are being systematically enlarged and improved. Broad interdisciplinary strengths are based upon related material activities in several

other curricula in the School of Engineering and other schools of the University.

The prerequisite for graduate study in ceramic engineering is a proficiency in undergraduate courses leading to the bachelor's degree in ceramic engineering, or a substantial equivalent. A significant fraction of the current student body has come to ceramics with backgrounds in other science and engineering disciplines.

For course descriptions, see Ceramic Engineering, page 73.

METALLURGICAL ENGINEERING

The rapid development of space and nuclear technology and attendant materials problems has brought about a sharp increase in the demand for trained leaders in the materials fields. There is at present intense emphasis on advanced study and research on the fundamental behavior of metals and alloys. From this work will come urgently needed improvements in metallic materials of construction to withstand increasingly drastic service requirements—higher stresses, higher temperatures, corrosive and radioactive environments.

Opportunities for men with graduate training in metallurgy and metallurgical engineering are almost unlimited. Industry and universities today need approximately four times as many metallurgists with advanced degrees as are available. It has been estimated that by 1975 the electrical, chemical, aerospace and nuclear industries will require 50,000 research metallurgists and metallurgical engineers. The number presently available is approximately 12,000. Present ratios indicate that one-third to one-half of the 50,000 graduates needed should have advanced training beyond the bachelor's degree. The shortage of graduates with advanced degrees is further accentuated by the need for qualified college faculty members to provide adequate instruction in metallurgical and related fields.

North Carolina State University is one of the few institutions in the South, and the only institution in North Carolina, prepared to offer graduate instruction in metallurgical engineering. In this program special emphasis is placed upon the application of basic physical metallurgy to problems encountered in various engineering disciplines including mechanical design, corrosive and reactive environments, and nuclear reactor applications. Appropriate opportunities for graduate thesis research are available in each of these areas. In addition to the advanced work in metallurgical engineering, the School of Engineering also offers an excellent program of supporting courses at the graduate level in the related fields of physics, chemistry, mathematics, engineering mechanics and in mechanical, chemical, ceramic and nuclear engineering.

For course descriptions, see Metallurgical Engineering, page 195.

MODERN LANGUAGES

GRADUATE FACULTY

Professor GEORGE W. POLAND, *Head*

Professor: EDWARD M. STACK; *Associate Professor:* HARRY TUCKER, JR.;

Assistant Professor: GLORIA M. FRY

The Department of Modern Languages offers courses to assist graduate students in preparing themselves to use modern foreign languages in research and advanced study. Students are given the opportunity of working a translation project in connection with their subject of major interest. They are encouraged particularly to seek useful foreign research related to their thesis or other research in progress. Although these courses do not carry graduate language credit, they may be taken as a means of attaining a reading knowledge.

Certification may be obtained in languages not normally taught by the department with special permission of the Graduate School.

MLF 401 FRENCH GRAMMAR FOR GRADUATE STUDENTS 3(3-0) FS

This course is designed to present the grammar of scientific French as rapidly as possible in preparation for the reading course which follows.

MLF 402 SCIENTIFIC FRENCH 3(3-0) FS

Prerequisite: MLF 401 or equivalent

Reading and translation of technical French, supplemented by discussion on terminology, word order, vocabulary analysis and other linguistic techniques. Subject material adjusted to individual needs; conferences.

MLG 401 GERMAN GRAMMAR FOR GRADUATE STUDENTS 3(3-0) FS

This course is designed to present the grammar of scientific German as rapidly as possible in preparation for the reading course which follows.

MLG 402 SCIENTIFIC GERMAN 3(3-0) FS

Prerequisite: MLG 401 or equivalent

Reading and translation of technical German, supplemented by discussions of terminology, word order, vocabulary analysis and other linguistic techniques. Subject material adjusted to individual needs; conferences.

MLS 401 SPANISH GRAMMAR FOR GRADUATE STUDENTS 3(3-0) FS

This course is designed to present the grammar of scientific Spanish as rapidly as possible in preparation for the reading course which follows.

MLS 402 SCIENTIFIC SPANISH 3(3-0) FS

Prerequisite: MLS 401 or equivalent

Reading and translation of technical Spanish, supplemented by discussions on terminology, word order, vocabulary analysis and other linguistic techniques. Subject material adjusted to individual needs; conferences.

NUCLEAR ENGINEERING

GRADUATE FACULTY

Professor RAYMOND L. MURRAY, *Head*

Professors: JOE R. BEELER, JR., RAYMOND F. SAXE, LLOYD R. ZUMWALT;
Adjunct Professor: RALPH L. ELY, JR.; *Associate Professors:* JAMES R. BOHANNON, JR., *Nuclear Operations Administrator*, ALBERT CARNE-SALE, THOMAS S. ELLEMAN, *Graduate Administrator*, ROBIN P. GARDNER, WILLIAM E. KIKER, *Assistant Professors:* CHARLES E. SIEWERT, KURUVILLA VERGHESE

ASSOCIATE MEMBERS OF THE DEPARTMENT

Professors: TIEN S. CHANG, WESLEY O. DOGGETT, JAMES K. FERRELL, M. NECATI OZISIK, CHARLES SMALLWOOD, JR., ARTHUR W. WALTNER;
Associate Professors: LAWRENCE H. BOWEN, ALONZO F. COOTS, EDWARD G. MANNING

The Department of Nuclear Engineering offers graduate study leading to the Master of Science and Doctor of Philosophy degrees.

Courses and research are available within the department and cooperating departments in several areas of nuclear engineering, including reactor theory and analysis, radiation detection, nuclear materials, radiation effects, energy transfer and conversion, nuclear safety and instrumentation, and radiation applications.

Among the available research facilities are: a 10-kilowatt heterogeneous, tank-type reactor, 26,000-curie Cobalt-60 gamma irradiation source; natural uranium subcritical assembly; 1-Mev pulsed van de Graaff accelerator; pulsed neutron generator; laboratories for neutron activation analysis, radiochemistry, gaseous discharge, reactor noise analysis, diffusion in materials; high-pressure heat-transfer loop; and digital and analog computers. Future facilities under design include a one-megawatt steady-state and pulse type reactor (PULSTAR) and a 50,000 square foot Nuclear Science and Engineering Research Center.

Candidates for admission are expected to hold the bachelor's degree in one of the fields of engineering or the physical sciences. Experience in nuclear physics, advanced differential equations and basic reactor theory will reduce the time required for completion of the degree. Courses in these areas can be included in the initial phases of the graduate program. Thirty semester hours (including four for research) and a thesis are required for the Master of Science degree. Well-qualified students may study directly toward the Doctor of Philosophy degree. Interdisciplinary research programs may be arranged for graduate students in cooperation with departments in the Schools of Engineering, Physical Sciences and Applied Mathematics, and Agriculture and Life Sciences.

The Department of Nuclear Engineering participates in the Nuclear Science and Engineering Fellowship Program of the Atomic Energy Commission. Students are also eligible for fellowships from the Ford Foundation, the National Science Foundation, the National Aeronautics and Space Administration, and others. Half-time graduate teaching or research assistantships are available in which a nine-hour load per semester is permitted.

Graduates of the department find positions in industry, government and academic institutions. Opportunities include analysis, design, utilization and operation of nuclear facilities associated with the nuclear aerospace program, power reactors, research reactors and radioisotopes applications.

FOR ADVANCED UNDERGRADUATES

NE 404 NUCLEAR ENERGY CONVERSION I

3(3-0) F

Prerequisite: CHE 421 or equivalent

Basic principles of the transformation of nuclear energy into useful forms. Considers the reactor as a heat source for a heat engine cycle. Description and analysis of various reactor concepts and associated power plants.

NE 405 NUCLEAR ENERGY CONVERSION II 3(3-0) S

Prerequisite: CHE 422 or equivalent

Basic principles of the transformation of nuclear energy into useful forms. Considers isotope production and utilization, direct conversion techniques, nuclear propulsion concepts, research reactors and breeder reactors.

NE 419 INTRODUCTION TO NUCLEAR ENGINEERING 3(3-0) FS

Prerequisite: PY 407

A survey of nuclear energy applications, including nuclear reactor materials, reactor theory, shielding, thermal and hydraulic analysis, and control. Uses of nuclear fission and its byproducts in research, industry and propulsion are reviewed. The major engineering problems are defined and methods of approach are outlined.

FOR GRADUATES AND ADVANCED UNDERGRADUATES**NE 503 NUCLEAR ENGINEERING SYSTEMS** 3(3-0) S

Prerequisite: NE 530

Considers reactor as a system including aspects of reactor control, radiation protection, shielding and thermal design. Mr. Carnesale

NE 511 RADIATION DETECTION AND ANALYSIS 3(1-4) FS

Prerequisite: PY 410

Interaction of radiation with detectors. Characteristics of detectors and analysis equipment. Statistics of the counting process. Emphasis is on preparation for use of radiation counting equipment for research. Mr. Kiker

NE 518 RADIOLOGICAL SAFETY 3(3-0) S

Prerequisites: NE 530, PY 410

Brief treatment of types of radiation and their interaction with matter, shielding and biological effects. More detailed study of safety considerations in a nuclear installation, including regulations, instrumentation used, overall detection system, emergency situations and radiation containment. An attempt will be made to gain an overall picture of the safety considerations in a nuclear installation. Mr. Elleman

NE 530 INTRODUCTION TO NUCLEAR REACTOR THEORY 3(3-0) S

Prerequisite: PY 410

The principles of neutron motion in matter, with emphasis on the analysis of the nuclear chain reactor. Slowing of neutrons, diffusion, space distributions of flux, conditions for criticality, group theories and the time-dependent behavior of fissionable assemblies. Mr. Carnesale

NE 531 NUCLEAR REACTOR LABORATORY 2(0-6) FS

Prerequisite: NE 530

Observation and measurements of static and dynamic nuclear reactor behavior, the effectiveness of control and temperature and correlation with theory. Experiments on the motion and detection of neutrons and gamma rays, with emphasis on the research uses of nuclear reactor radiations. Messrs. Kiker, Verghese

NE 532 NUCLEAR ENGINEERING LABORATORY**2(0-6) F****Prerequisite:** NE 419

This laboratory course will provide a series of experiments that are fundamental to nuclear engineering. Special emphasis will be on experiments related to nuclear reactor theory, reactor kinetics, neutron physics, reactor heat transfer and radiochemistry applications. Several experiments in conjunction with an analog computer will be performed. Familiarization with research equipment will be gained through active participation of the student in setting up the various measurements.

Mr. Saxe**NE 540 NUCLEAR REACTOR CONTROL****3(3-0) S****Prerequisite:** NE 503 or NE 530

Considers nonsteady-state thermal and fast reactor behavior including reactivity effects due to temperature, poisoning and control rods. Uses elementary servo-mechanism theory in treating the reactor as a control element. Treats automatic control including control mechanisms and dynamic effect of power plant characteristics.

Mr. Saxe**NE 545 NUCLEAR REACTOR KINETICS****3(3-0) F****Prerequisite:** NE 503 or NE 530

The kinetic behavior of thermal and fast nuclear reactors is carefully analyzed from both theoretical and experimental viewpoints. Solutions of the basic kinetic equations are developed and applied to specific reactor behavior. Temperature, void and xenon poisoning effects are considered. Digital and analog computer techniques are discussed and utilized. Correlation of theory with observed reactor behavior is made and safety consideration in reactor design is discussed.

Mr. Saxe**NE 550 RADIATION UTILIZATION****3(3-0) F****Prerequisites:** PY 410, NE 511 or equivalent

Theory, industrial application and economics of nuclear radiation are discussed. Emphasis is on the ability to choose appropriate forms of radiation and to design practical equipment. Subjects covered include: origin and economics of radiation, tracer techniques, activation analysis, food irradiation, chemonuclear processing, low- and high-level sealed source devices, and unique engineering aspects.

Messrs. Ely, Gardner**NE 562 (MIM 562) MATERIALS PROBLEMS IN NUCLEAR ENGINEERING****3(3-0) S****Prerequisites:** MIM 422, PY 410, or equivalent

Those reactor component design considerations determined by materials properties as well as nuclear function will be discussed. Emphasis will be placed on radiation metallurgical processes in materials pertinent to fast reactors for either terrestrial or space application. At present the most pressing problems are concerned with maintaining good mechanical property response during extended exposure to neutron irradiation.

Mr. Beeler**NE 570 RADIATION EFFECTS ON MATERIALS****3(3-0) F****Prerequisites:** MIM 202, PY 407

A study of the interactions of different types of radiation with matter, with emphasis on the physical effects. Current theories will be evaluated and experimental techniques will be discussed. Annealing of defects and radiation induced changes in physical properties will be investigated in detail.

Mr. Elleman

NE 591, 592 SPECIAL TOPICS IN NUCLEAR ENGINEERING I, II 3(3-0) FS
Prerequisite: Consent of instructor

These courses will be used to explore unusual and/or specialized areas of nuclear engineering. Graduate Staff

FOR GRADUATES ONLY

NE 619 REACTOR THEORY AND ANALYSIS I 3(3-0) F
Prerequisite: NE 503 or NE 530

The theory of neutron slowing, resonance capture, Doppler effect and thermal flux distributions in heterogeneous nuclear reactors. Analysis of reactor control by temperature, effects of localized and distributed absorbers, fission products, fuel consumption and production. One-velocity neutron transport theory.

Mr. Murray

NE 620 NUCLEAR RADIATION ATTENUATION 3(3-0) F
Prerequisite: NE 503

The physical theory and mathematical analysis of the penetration of neutrons, gamma-rays and charged particles. Analytical techniques include point kernels, transport theory, Monte Carlo and numerical methods. Digital computers are employed in the solution of practical problems.

Mr. Siewert

NE 630 REACTOR THEORY AND ANALYSIS II 3(3-0) S
Prerequisite: NE 503 or NE 530

The theory of neutron multiplication in uniform media with several dimensions, regions and neutron energy groups. Reactor control by absorbers, time dependent reactor behavior, matrix treatment of perturbation theory, neutron thermalization, energy dependent neutron transport theory and multigroup machine methods.

Mr. Murray

NE 651 ADVANCED REACTOR THEORY 3(3-0) F
Prerequisites: NE 619, NE 630

A presentation of the latest advances in the mathematical analysis of nuclear reactor systems behavior, with special emphasis on neutron transport theory. Investigations of new reactor concepts, the development of experimental measurement techniques and methods of interpretation. Evaluation of computer methods for design calculations.

Mr. Siewert

NE 653 NUCLEAR REACTOR DESIGN 3(3-0) S
Corequisites: NE 619, NE 630

A comprehensive analysis and design of a nuclear reactor system for a specified application will be performed. Considerations will include criticality, control, lifetime, thermal-hydraulic, shielding, economics, power conversion and optimization procedures. Selected application will be varied each year.

Mr. Bohannon

NE 691, 692 ADVANCED TOPICS IN NUCLEAR ENGINEERING I, II 3(3-0) FS
Prerequisite: Consent of instructor

A study of recent developments in nuclear engineering theory and practice.

Graduate Staff

NE 695 SEMINAR IN NUCLEAR ENGINEERING 1(1-0)

Discussion of selected topics in nuclear engineering.

Graduate Staff

NE 699 RESEARCH IN NUCLEAR ENGINEERING Credits Arranged

Prerequisite: Graduate standing

Individual research in the field of nuclear engineering.

Graduate Staff

OCEANOLOGY

The oceans are perhaps man's last great frontier on earth. Recent developments have made clear how little man really knows of this vast environment and its resources. Further understanding of the oceans and effective utilization of their resources depends upon a thorough knowledge of the geography of the sea and its logistics, the mineral resources of the sea and their extraction, the biological resources of the sea and their utilization, ocean pollution, and deep sea and coastal engineering. North Carolina is richly endowed with marine environments and resources. The state has over 300 miles of shoreline which enclose almost 2,500 square miles of shallow sounds and associated habitats. In addition, an extensive continental shelf and proximity to the Gulf Stream and cold northern waters make for rich and varied opportunities for the study of marine science.

North Carolina State University offers an individual majoring in an established departmental program the opportunity to minor in oceanology. Students in the Schools of Agriculture and Life Science, Engineering, and Physical Science and Applied Mathematics may major in a department appropriate to their primary subject matter interest and minor in oceanology. It is anticipated that opportunities for a full major in oceanology will soon exist.

A variety of facilities are available to students wishing to minor in oceanology. North Carolina State University has laboratories on the coast at Hatteras and Aurora administered by the Department of Zoology. Students may also use the facilities of the Institute of Marine Science of the University of North Carolina at Chapel Hill and the U. S. Fish and Wildlife Service Radiobiology Lab at Beaufort. Course offerings on the Raleigh campus are supplemented by courses at Chapel Hill and Duke University with which reciprocal tuition arrangements can be made. In addition, individuals with special interests in coastal engineering and protection, coastal geology and coastal ecology may participate in the research of members of the North Carolina Coastal Research Program.

The minor program in oceanology is supervised by a steering committee composed of one member of the graduate faculty with competence in marine science from each cooperating department. The steering committee, plus other graduate faculty members with competence in marine science, compose the oceanology faculty. Departments cooperating at present are botany, civil engineering, food science, geology and zoology.

A student minoring in oceanology will be expected to demonstrate competence in the basic principles of the field. The following courses have been designated as the core of the oceanology program:

OC 487 (CE 487, GY 487) Physical Oceanography

OC 529 (ZO 529) Biological Oceanography

OC 584 (GY 584) Marine Geology

OC 591, 592 Seminar in Oceanology

A candidate for the Master of Science degree would normally take, as a recommended minimum, at least two of the core courses (or their equiva-

lents), at least one of the seminar courses and at least one other course from the recommended list of courses offered by cooperating departments or all three of the core courses plus the seminar. The recommended minimum core for the Doctor of Philosophy degree would normally include all three core courses (or their equivalents), at least one of the seminar courses and at least two other courses from the recommended list. The graduate committee for a student minoring in oceanology will always include at least one member of the oceanology faculty.

Communications concerning the oceanology program, including inquiries from students wishing to minor in oceanology, should be directed to the Chairman of the Oceanology Program Steering Committee, in care of the Graduate School, North Carolina State University or to a participating department.

FOR ADVANCED UNDERGRADUATES

OC 487 (CE 487, GY 487) PHYSICAL OCEANOGRAPHY 3(3-0) S

An introduction to the principles of physical oceanography. Subjects to be covered are: history of physical oceanography; the geological and astronomical background for the field; tides and waves; fluid mechanics; characteristics of sea water; advective and convective processes; current measurements; laboratory models; and specific problems in physical oceanography.

FOR GRADUATES AND ADVANCED UNDERGRADUATES

OC 529 (ZO 529) BIOLOGICAL OCEANOGRAPHY 3(3-0) Sum.
(See Zoology, page 256.)

OC 584 (GY 584) MARINE GEOLOGY 3(3-0) S
(See Geosciences, page 156.)

OC 591, 592 SEMINAR IN OCEANOLOGY 1(1-0) FS

A seminar designed to give perspective in the field of oceanology. Topics vary from semester to semester. In order to obtain credit a student must deliver a seminar.

RECOMMENDED COURSES IN COOPERATING DEPARTMENTS BIOLOGICAL OCEANOLOGY

BO 442 (ZO 442) GENERAL ECOLOGY

BO 574 (MB 574) PHYCOLOGY

MB 401, 402 GENERAL MICROBIOLOGY

ZO 420 FISHERY SCIENCE

ZO 441 ICHTHYOLOGY

ZO 515 GROWTH AND REPRODUCTION OF FISHES

ZO 517 POPULATION ECOLOGY

ZO 519 LIMNOLOGY

ZO 619 ADVANCED LIMNOLOGY

ZO 621 FISHERY SCIENCE

GEOLOGICAL OCEANOLOGY

GY 452 EXOGENIC MATERIALS AND PROCESSES

GY 552 EXPLORATORY GEOPHYSICS

GY 563 APPLIED SEDIMENTOLOGY

GY 567 GEOCHEMISTRY

SSC 553 SOIL MINERALOGY

PHYSICAL OCEANOLOGY

CE 517 WATER TRANSPORTATION

CE 548, 549 ENGINEERING PROPERTIES OF SOILS I, II

CE 581 INTRODUCTION TO OCEANOGRAPHIC ENGINEERING

CE 641, 642 ADVANCED SOIL MECHANICS

EM 504 MECHANICS OF IDEAL FLUIDS

EM 505 MECHANICS OF VISCOUS FLUIDS I

EM 612 MECHANICS OF VISCOUS FLUIDS II

MAE 651 PRINCIPLES OF FLUID MOTION

OPERATIONS RESEARCH

(An interdepartmental graduate program.)

OPERATIONS RESEARCH TECHNICAL COMMITTEE

Professors: JOHN F. BOGDAN, ROBERT G. CARSON, JR., FREDERICK P. BROOKS, JR., ARTHUR R. ECKELS, SALAH E. ELMAGHRABY, *Chairman*, PAUL E. LEWIS, HOWARD G. MILLER, GEORGE E. NICHOLSON, JR., WALTER J. PETERSON, *ex officio*, HAROLD F. ROBINSON, *ex officio*; *Associate Professors:* BIBHUTI B. BHATTACHARYYA, WILLIAM L. HAFLEY, CLEON HARRELL, RICHARD I. LEVIN, DAVID A. LINK, CLARENCE J. MADAY, DONALD C. MARTIN; *Assistant Professors:* WILLIAM S. GALLER, H. ALLAN KNAPPENBERGER

ASSOCIATED GRADUATE FACULTY

Professors: WILLIAM J. BARCLAY, FREDRICK P. BROOKS, ARTHUR R. ECKELS, SALAH E. ELMAGHRABY, ARNOLD H. E. GRANDAGE, ROBERT J. HADER, WILLIAM R. HENRY, ROBERT W. LLEWELLYN, ROBERT J. MONROE, GEORGE E. NICHOLSON, BERNARD M. OLSEN, CHARLES H. PROCTOR, HANS SAGAN, WALTER L. SMITH, HUBERTUS R. VAN DER VAART,

THOMAS D. WALLACE, OSCAR WESLER; *Visiting Professor*: MAKOTO ITOH; *Associate Professors*: RAUL E. ALVAREZ, NORMAN R. BELL, BIBHUTI B. BHATTACHARYYA, JOHN W. BISHIR, RICHARD CHANDLER, JAMES H. DORNBERG, WILLIAM L. HAFLEY, CLEON HARRELL, LAURENCE J. HERBST, RICHARD I. LEVIN, DAVID A. LINK, CLARENCE J. MADAY, DONALD C. MARTIN, WILBUR C. PETERSON, JAMES A. SEAGRAVES, EDWARD H. WISER; *Assistant Professors*: WILLIAM S. GALLER, H. ALLAN KNAPPENBERGER, RONALD A. SCHRIMPER

Operations Research is the application of scientific methods, techniques and tools to problems involving the operations of a system so as to provide those in control of the system with objective and quantitative bases for optimum solutions to the problems. In other words, Operations Research is the study of administrative systems pursued in the same scientific manner in which systems in physics, chemistry, engineering and biology are studied. The objective of the study is to gain understanding of these systems so that they may be more readily controlled and can, in fact, be harnessed to man's uses.

A review of the brief history of Operations Research since World War II reveals that one characteristic is that it is interdisciplinary. It draws on techniques from mathematics, economics, physics, engineering and so on, and distills from among these techniques the ones which apply in the system being studied. Another characteristic is that, above all, Operations Research is an attitude of mind. The attitude of mind of an inquiring scientist who is not content with accepting a system as it is, but who wants to analyze it, find out 'what makes it tick', see how it responds to stimuli and encourage it to evolve in the best directions.

Operations Research has found wide applicability in the military, where it originally started, in industry and in government, both at the state and federal levels. Operations researchers have been confronted with a wide spectrum of problems varying from the determination of the optimal inventory to be carried by a firm in the face of uncertain demand, to the planning of the allocation of national resources in the case of emergency.

At North Carolina State University at Raleigh and the University of North Carolina at Chapel Hill, graduate courses in many areas of operations research have been offered by various departments for a number of years. In addition, numerous operations research theses have been directed by staff members of these departments. Recognizing the need to coordinate and expand these activities, an Operations Research Committee has been appointed, consisting of representatives from the Departments of Biological and Agricultural Engineering, Economics, Electrical Engineering, Experimental Statistics, Industrial Engineering, Mathematics, Psychology, the School of Forest Resources and the School of Textiles at Raleigh and the Departments of Statistics, Information Science and the School of Business Administration at Chapel Hill.

Because of the many-faceted nature of Operations Research and its applicability to a wide range of fields of study, the O.R. Committee has established a strong graduate minor program in O.R., with the major in any basic discipline which could contribute to or utilize Operations Research. It is recognized, as has been recognized by many other universities, that

research in some major fields, such as industrial engineering and statistics, may be construed as research in O.R. This recognition has been reflected in the flexibility awarded to the design of the courses of study of any particular M.Sc. or Ph.D. candidate by his master's or doctoral committee.

It has also been reflected in the organization of courses for the minor in O.R. into 'Central' and 'Cognate' courses. The 'Central' courses represent the core of the body of knowledge which has come to be associated with Operations Research. The 'Cognate' courses are intended to assist the graduate student and his advisory committee in charting his program for optimal self-development and specialized education.

A comprehensive study of O.R. usually implies intensive study and proficiency in at least a few of the following areas of knowledge:

- Mathematical Theories of Optimization
- Control Systems, Reliability and Cybernetics
- Econometrics and Economic Decision Theory
- Information and Computer Sciences
- Probability and Statistics

If a student majors in a discipline which demands a high level of proficiency in one (or more) of these areas, he would be expected to take courses from this area (or areas) as part of the major and select the O.R. courses from other areas. The student's committee is guided by the spirit of the need to complement the student's knowledge and to broaden his scope. The cohesive elements in the O.R. graduate program are to be the introductory survey to O.R. and the Seminar.

The minimal course requirements for graduate minors in O.R. are as follows:

Master's Degree—the introductory course, the seminar and two complementary courses, with at least one from the central courses list;

Doctoral Degrees—the introductory course, the seminar, and five complementary courses with at least two from the central courses list.

Prospective students should pay particular attention to the prerequisites for the courses chosen. A student minoring in operations research should have a good background in matrix algebra, advanced calculus and introductory probability, or be prepared to take such courses early in his graduate program. The Departments of Electrical Engineering and Industrial Engineering have developed one-semester courses (EE 430, Essentials of Electrical Engineering; IE 510, Industrial Engineering Methods) to qualify nonengineers to enter certain courses in the areas of control systems and reliability and information and computer science. Such background courses cannot be counted as part of the operations research minor program.

ADMISSION

Prospective graduate students at either the Raleigh or the Chapel Hill campus of the Consolidated University of North Carolina should contact the graduate dean at the selected institution for Application for Admission forms and for a copy of the graduate catalog. Space is provided on the application forms to indicate a desire for an O.R. minor. The graduate

catalog presents the requirements for admission to and the relations of the Graduate School and a description of departmental programs and course offerings.

General information regarding the Operations Research Program can be obtained from

Dr. Salah E. Elmaghraby, Chairman
Operations Research Committee
Box 5518
Raleigh, N.C. 27607

Information can also be obtained from the departments and schools represented on the O.R. Committee.

Both teaching and research assistantships are available to qualified applicants each year from the departments and schools represented on the Operations Research Committee. Requests for such assistance should be directed to these departments and schools or to the Chairman of the O.R. Committee.

CENTRAL COURSES IN OPERATIONS RESEARCH*

OR 501 INTRODUCTION TO OPERATIONS RESEARCH 3(3-0) F
Prerequisites: MA 405, MA 421, required of all O.R. minors

O.R. Approach: Modeling, constraints, objective and criterion. The problem of multiple criteria. Optimization. Model validation. The team approach. Systems design. Examples. O.R. Methodology: Mathematical programming; optimum seeking; simulation, gaming; heuristic programming. Examples. O.R. Applications: Theory of inventory: economic ordering under deterministic and stochastic demand. The production smoothing problem: linear and quadratic cost functions. Waiting line problems: single and multiple servers with Poisson input and output. The theory of games for 2-person competitive situations. Project Management through PERT-CPM. Mr. Elmaghraby

OR 505 (IE 505, MA 505) MATHEMATICAL PROGRAMMING I 3(3-0) F
Prerequisite: MA 405

A study of mathematical methods applied to problems of planning. Linear programming will be covered in detail. This course is intended for those who desire to study this subject in depth and detail. It provides a rigorous and complete development of the theoretical and computational aspects of this technique as well as a discussion of a number of applications. Mr. Llewellyn

OR 522 (IE 522) DYNAMICS OF INDUSTRIAL SYSTEMS 3(3-0) S
Prerequisite: IE 421

A study of the dynamic properties of industrial systems; introduction to servomechanism theory as applied to company operations. Simulation of large non-linear, multi-loop, stochastic systems on a digital computer; methods of determining modifications in systems design and/or operating parameters for improved system behavior. Mr. Knappenberger

UNC ST 202 METHODS OF OPERATIONS RESEARCH 3(3-0) F
Prerequisite: UNC ST 135

Linear programming, theory of games, techniques for analyzing waiting lines

* Courses with numbers beginning with 1 or 2 are taught on the Chapel Hill campus; others are taught at Raleigh.

and queues. Applied probability, recent developments, applications of results to specific problems. Case studies. Messrs. Nicholson, Smith

OR 606 (MA 606, ST 606) MATHEMATICAL PROGRAMMING II 3(3-0) S
Prerequisite: IE 505

This course is intended for those who desire to study linear and nonlinear programming from an advanced mathematical point of view. Special attention will be paid to the theoretical and computational aspects of current research problems in the field of mathematical programming, including linear programming and game theory, theory of graphs, discrete linear programming, linear programming under uncertainty and nonlinear programming. Mr. Bhattacharyya

OR 607 (IE 607, MA 607) SELECTED TOPICS IN MATHEMATICAL PROGRAMMING 3(3-0) S
Prerequisite: IE 505

This course is a continuation of OR 505 (IE 505). Special techniques like the decomposition principles, network problems, diophantine programming as well as its applications to industrial problems are studied. An introduction to dynamic programming will also be covered. Multistage decision problems will be worked using linear and dynamic programming. The theoretical foundation of these techniques will be covered but emphasis will be in the applications to planning problems. Mr. Alvarez

OR 621 (IE 621) INVENTORY CONTROL METHODS I 3(3-0) FS
Prerequisites: IE 402, ST 421, MA 511

A study of inventory policy with respect to reorder sizes, minimum points, and production schedules. Simple inventory models with restrictions, price breaks, price changes, analysis of slow-moving inventories. Introduction to the smoothing problem in continuous manufacturing. Applications of linear and dynamic programming and zero-sum game theory. Mr. Alvarez

OR 691 SPECIAL TOPICS IN OPERATIONS RESEARCH 3(3-0) FS
Prerequisites: OR 501, OR 505

The purpose of this course is to allow individual students or small groups of students to take on studies of special areas in O.R. which fit into their particular program and which may not be covered by other O.R. courses. The work will be directed by a qualified faculty member and in some instances by visiting professors. The subject matter in any year is dependent on the students and the faculty member. Graduate Staff

OR 695 SEMINAR IN OPERATIONS RESEARCH 1(1-0) FS
Prerequisites: Enrollment in O.R. minor

Seminar discussion of operations research problems. Case analyses and reports. Graduate students with minors in operations research are expected to attend throughout the period of their residence. Mr. Elmaghraby

SUGGESTED COGNATE COURSES

ECONOMICS

EC 550 MATHEMATICAL MODELS IN ECONOMICS

EC 555 LINEAR PROGRAMMING

EC 650 ECONOMIC DECISION THEORY

EC 651, 652, (ST 651, 652) ECONOMETRIC METHODS I & II

EC 655 TOPICS IN MATHEMATICAL ECONOMICS

ELECTRICAL ENGINEERING

EE 506 DYNAMICAL ANALOGIES
 EE 516 FEEDBACK CONTROL SYSTEMS
 EE 520 FUNDAMENTALS OF LOGIC SYSTEMS
 EE 521 DIGITAL COMPUTER TECHNOLOGY AND DESIGN
 EE 613, 614 ADVANCED FEEDBACK CONTROL
 EE 642 AUTOMATA AND ADAPTIVE SYSTEMS

INDUSTRIAL ENGINEERING

IE 521 CONTROL SYSTEMS AND DATA PROCESSING
 IE 547 ENGINEERING RELIABILITY
 IE 622 INVENTORY CONTROL METHODS II

INFORMATION SCIENCE

IS 160 INTRODUCTION TO AUTOMATIC DIGITAL CONTROL
 IS 210 PROCESSING OF NATURAL AND ARTIFICIAL LANGUAGES
 IS 211 TUTORIAL IN INFORMATION RETRIEVAL

MATHEMATICS

MA 521 A SURVEY OF MODERN ALGEBRA
 MA 536 LOGIC FOR DIGITAL COMPUTERS
 MA 537 MATHEMATICAL THEORY OF DIGITAL COMPUTERS
 MA 541 (ST 541) THEORY OF PROBABILITY I
 MA 542 (ST 542) THEORY OF PROBABILITY II
 MA 617, 618, (ST 617, 618) MEASURE THEORY AND ADVANCED PROBABILITY
 MA 619 (ST 619) TOPICS IN ADVANCED PROBABILITY
 MA 622 LINEAR ALGEBRA
 MA 641 CALCULUS OF VARIATIONS

STATISTICS

U.N.C. ST 131 ELEMENTARY PROBABILITY
 U.N.C. ST 132 INTERMEDIATE PROBABILITY
 ST 611, 612 INTERMEDIATE STATISTICAL THEORY
 ST 613, 614 TIME SERIES ANALYSIS I & II
 U.N.C. ST 231 ADVANCED PROBABILITY
 U.N.C. ST 235 STOCHASTIC PROCESSES
 U.N.C. ST 252 INFORMATION THEORY
 ST 691 SPECIAL TOPICS (QUEUEING THEORY, FALL 1968)

PHYSICS

GRADUATE FACULTY

Professor LEWIS W. SEAGONDOLLAR, *Head*

Professors: WILLARD H. BENNETT, JOHN M. A. DANBY, WILLIAM R. DAVIS, WESLEY O. DOGGETT, GEORGE L. HALL, HARRY C. KELLY, FORREST W. LANCASTER, JOSEPH T. LYNN, *Graduate Administrator*, EDWARD R. MANRING, JASPER D. MEMORY, ARTHUR C. MENIUS, JR., RAYMOND L. MURRAY, ARTHUR W. WALTNER; *Visiting Professor:* CORNELIUS LANCZOS; *Professors Emeriti:* JEFFERSON S. MEARES, RUFUS H. SNYDER; *Associate Professors:* FRIEDRICH G. EVERLING, ALVIN W. JENKINS, JR., GERALD H. KATZIN, MARVIN K. MOSS, RICHARD R. PATTY, DAVID R. TILLEY; *Assistant Professors:* GROVER C. COBB, JR., DAVID H. MARTIN, JAE Y. PARK, GEORGE W. PARKER, III, JAMES W. YORK, JR.

Study in physics is available leading to the degrees Master of Science and Doctor of Philosophy. In addition to the areas of research listed below, thesis work may also be done in closely related departments in the fields of biophysics, environmental sciences, nuclear reactor theory and computer science. There are available to the department the computer facilities (including the IBM System 360/75 computer) of the nearby Triangle Universities Computation Center which is jointly operated by Duke University, the University of North Carolina at Chapel Hill and N. C. State University.

Programs of study leading to the Master of Science degree require a minimum of 30 semester hours, including four credits of research and two of seminar. In addition, a thesis is required and a reading knowledge of Russian, German or French.

The Doctor of Philosophy degree is granted on successful completion of examinations, independent research and the submission of an acceptable dissertation. A minor area of study is required, mathematics usually being elected. The student is required to have a reading knowledge of two of the three languages Russian, German, French or a knowledge in depth of one of these.

All graduate students and staff are expected to attend a weekly colloquium at which topics of current interest in physics are discussed.

The Department of Physics participates in a number of fellowship programs such as those of the National Science Foundation and the National Aeronautics and Space Administration. In addition, many teaching and research assistantships are available. Depending upon the student's experience, these pay from \$2,700 to \$3,600 for half-time duties during the nine-month school year and entitle the holder to in-state tuition rates. A student holding such a half-time assistantship may carry 60 percent of a full course load.

Staff and facilities are available for special study and research at both the master's and doctoral levels in the areas listed below. In most of these areas the work is supported by grants or contracts, and research assistantships are available.

ATMOSPHERIC PHYSICS

A number of atmospheric problems, including the electromagnetic properties of the upper atmosphere, are being investigated both theoretically

and experimentally. An observing site remote from city lights has been constructed.

MAGNETIC RESONANCE

A Varian HA-100 spectrometer equipped with a CAT is used for studying high resolution NMR spectra of polycyclic and heterocyclic compounds and the relaxation mechanisms in complex spin systems.

NUCLEAR PHYSICS

In addition to reactor oriented research using pulsed neutrons which is carried out on the N. C. State campus, the department participates in research at the Regional Nuclear Laboratory which is located on the Duke University campus. This laboratory is under the direction of Professor Henry Newson of the Duke University physics department, and jointly staffed by Duke University, the University of North Carolina at Chapel Hill and N. C. State University. The major facility there is a 15 MeV Model FN Tandem Van de Graaff accelerator with a 15 MeV cyclotron injector and on-line computer equipment.

PLASMA PHYSICS

The plasma research program is investigating various aspects of the behavior of charged particle beams. The program is supported by well-equipped machine shops and tube-making facilities staffed with skilled technicians. Off-campus facilities available include a 10 million volt pulsed X-ray machine and auxiliary equipment.

STATISTICAL AND SOLID-STATE PHYSICS

The broad area of interest of the theoretical work is in the quantum theory of cooperative phenomena in solids. Although most of the work is analytical, computer facilities (including the IBM System 360/75) are available for numerical calculations. The experimental work is largely concerned with the optical properties of solids, particularly laser materials.

RELATIVITY AND GENERAL FIELD THEORY

At present, investigation is centered on the formulation of the differential and integral conservation laws of the general theory of relativity and general field theory, and on the symmetry properties of Riemannian spacetimes.

FOR ADVANCED UNDERGRADUATES

PY 407 INTRODUCTION TO MODERN PHYSICS

3(3-0) FS

Prerequisites: MA 202, PY 208

A survey of the important developments in atomic and nuclear physics of this century. Among topics covered are: atomic and molecular structure, determination of properties of ions and fundamental particles, the origin of spectra, ion accelerators and nuclear reactions.

PY 410 NUCLEAR PHYSICS I**4(3-2) FS****Prerequisite:** PY 207 or PY 407

An introduction to the properties of the nucleus, and the interaction of radiation with matter. A quantitative description is given of natural and artificial radioactivity, nuclear reactions, fission, fusion and the structure of simple nuclei.

PY 411, 412 MECHANICS I, II**3(2-2) FS****Prerequisites:** MA 301, PY 207 or PY 208

A sequence of courses in intermediate theoretical mechanics, including the dynamics of particles and rigid bodies, gravitation and moving reference systems. An introduction is given to advanced mechanics, including D'Alembert's Principle and Lagrange's equations of motion, with applications.

PY 413 THERMAL PHYSICS**3(3-0) S****Prerequisite:** PY 206 or PY 208**Corequisite:** MA 301

An intermediate course in the principles of classical thermodynamics and the kinetic theory of gases with an introduction to statistical mechanics. Topics covered include equations of state, entropy, Maxwellian distributions, transport processes and the statistics of Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac.

PY 414, 415 ELECTRICITY AND MAGNETISM I, II**3(2-2) FS****Prerequisite:** PY 207 or PY 208**Corequisite:** MA 511

An intermediate course in the fundamentals of static and dynamic electricity and electromagnetic theory, developed from basic experimental laws. Vector methods are introduced and employed throughout the course.

PY 416 PHYSICAL OPTICS**3(2-2) S****Prerequisite:** PY 415

An intermediate course in physical optics with the major emphasis on the wave properties of light. Subjects covered include boundary conditions, optics of thin films, interference, diffraction and the Lorentz atom with applications to absorption, scattering and laser emission.

PY 499 SPECIAL PROBLEMS IN PHYSICS**1-3 FS****Prerequisite:** Consent of department

Study and research in special topics of classical and modern physics. Topics may be chosen for experimental or theoretical investigations, or a literature survey may be made.

FOR GRADUATES AND ADVANCED UNDERGRADUATES**PY 501, 502 INTRODUCTION TO QUANTUM MECHANICS I, II****3(3-0) FS****Prerequisites:** MA 511, PY 411 or PY 414

An introduction to the theory and methods of quantum mechanics, including the formalism of the theory and its interpretation, methods of approximation, and the application of the theory to simple physical systems.

Mr. Jenkins**PY 503, 504 INTRODUCTION TO THEORETICAL PHYSICS I, II****3(3-0) FS****Prerequisites:** MA 511, PY 412, PY 414

An introductory course in theoretical physics which offers preparation for

graduate study. Emphasis is on classical mechanics of particles and continuous media and special relativity. Topics covered include variational principles, canonical transformations, Hamilton-Jacobi theory, the transition to quantum mechanics, and the Lagrangian and Hamiltonian formalisms for fields. Mr. York

PY 507 ADVANCED ATOMIC PHYSICS 3(3-0) F
Prerequisites: MA 511, PY 412, PY 415

An introduction to the quantum mechanical treatment of atomic structure and spectra. Topics covered include the relativistic hydrogen atom, the helium atom, multielectron atoms, selection rules, etc. Mr. Parker

PY 509 PLASMA PHYSICS 3(3-0) F
Prerequisite: PY 414

A study of the individual and collective motion of charged particles in electric and magnetic fields and through ionized gases, including the pinch effect, relativistic streams, conductivities and runaway electrons. Astrophysical concepts and approximations and the properties of plasmas, with applications, are included. Mr. Bennett

PY 510 NUCLEAR PHYSICS II 4(3-2) F
Prerequisite: PY 410

A study of the properties of the atomic nucleus as revealed by radioactivity, nuclear reactions and scattering experiments with emphasis on the experimental approach. The laboratory is designed to stimulate independent research and offers project work in nuclear spectroscopy and in neutron physics. Mr. Waltner

PY 514, 515 ADVANCED ELECTRICITY AND MAGNETISM I, II 3(3-0) FS
Prerequisite: PY 415

An advanced treatment of electricity and magnetism and electromagnetic theory. Topics include: techniques for the solution of potential problems; development of Maxwell's equations; wave equations; energy, force and momentum relations of an electromagnetic field; special relativity and the Lorentz covariant formulation of electrodynamics; radiation from accelerated charges. Mr. Katzin

PY 517 MOLECULAR SPECTRA 3(3-0) S
Prerequisites: PY 407, PY 412; PY 507 recommended

Topics include the interpretation of infrared and Raman spectra for diatomic and simple polyatomic molecules; the effects due to vibration-rotation interaction, electronic motion and nuclear spin; nuclear magnetic resonance spectroscopy. The consequences of infrared absorption in the earth's atmosphere will be discussed. Mr. Patty

PY 518 RADIATION HAZARD AND PROTECTION 3(3-0) S
Prerequisite: PY 410

A study of the principles of radiation dosimetry, radiation hazards to man and methods of providing protection. Graduate Staff

PY 520 PHYSICAL MEASUREMENTS IN RADIOACTIVITY 3(2-2) S
Prerequisite: PY 410

The principles of experimental measurements on radioactive materials are presented and demonstrated through laboratory work. Emphasis is placed on the analytical interpretation of experimental data. Mr. Waltner

PY 552 INTRODUCTION TO THE STRUCTURE OF SOLIDS**3(3-0) S****Prerequisite:** PY 207 or PY 407**Corequisite:** PY 501

Basic considerations of crystalline solids, metals, conductors and semiconductors.

Mr. Parker**PY 555 (MA 555) PRINCIPLES OF ASTRODYNAMICS****3(3-0) S**

(See Mathematics, page 179.)

PY 599 SENIOR RESEARCH**3 FS****Prerequisite:** Senior honors program standing, except with special permission

Investigations in physics under the guidance of staff members which may consist of literature reviews, experimental measurements or theoretical studies.

Graduate Staff**FOR GRADUATES ONLY****PY 600 PLANETARY ATMOSPHERES****3(3-0) S****Prerequisite:** PY 507

Gas dynamics of atmospheres with emphasis on recent results of rocket, satellite and interplanetary probes. Theories of the airglow, aurora and ionosphere are developed.

Mr. Manring**PY 601, 602 THEORETICAL PHYSICS I, II****3(3-0) FS****Prerequisites:** PY 503, PY 514**Corequisite:** MA 661

The mathematical and theoretical approach to the relationships between various branches of physics is treated. The restricted theory of relativity, electrodynamics, classical field theory and the general theory of relativity are considered.

Mr. Davis**PY 609 HIGH ENERGY PHYSICS****3(3-0) S****Prerequisite:** PY 510

The experimental and theoretical aspects of nuclear processes at high energy are treated.

Graduate Staff**PY 610 ADVANCED NUCLEAR PHYSICS****3(3-0) F****Prerequisite:** PY 410**Corequisite:** PY 501

A theoretical study of nuclear structure and reactions. Topics include a review of the quantum theory of angular momentum, low energy nucleon-nucleon scattering, nuclear forces, polarization, direct reactions and current models of the nucleus.

Mr. Park**PY 611 QUANTUM MECHANICS****3(3-0) F****Prerequisites:** MA 512, PY 502

A treatment of nonrelativistic quantum mechanics at the advanced level, including an introduction to the relativistic quantum theory of Dirac particles and the methods of Feynman that are employed in his formulation of positron theory. Applications are made to scattering problems and to general problems of atomic and molecular structure.

Mr. Moss**PY 612 ADVANCED QUANTUM MECHANICS****3(3-0) S****Prerequisites:** PY 601, PY 611

A general propagator treatment of Dirac particles, photons, and scalar and

vector mesons with an introduction to quantum electrodynamics and S-matrix theory. Applications of Feynman graphs and rules will be given illustrating basic techniques employed in the treatment of electromagnetic, weak and strong interactions. Renormalization theory, the effects of radiative corrections, and aspects of the general Lorentz covariant theory of quantized fields will also be considered.

Mr. Moss

PY 621 KINETIC THEORY OF GASES

3(3-0) F

Prerequisites: MA 512, PY 501, PY 503

The theory of molecular motions, including velocity and density distribution functions; the phenomena of viscosity, heat conduction and diffusion; equations of state; fluctuations.

Mr. Patty

PY 622 STATISTICAL MECHANICS

3(3-0) S

Prerequisite: PY 413

Corequisite: PY 501

A treatment of equilibrium classical and quantum statistical mechanics. Topics include the statistics of Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein; microcanonical, canonical and grand canonical ensembles; Boltzmann's H-theorem; ideal Bose and Fermi gases; density matrix formalism; the theory of nonideal gases; cooperative phenomena.

Mr. Park

PY 641 NON-INERTIAL SPACE MECHANICS

3(3-0) S

Prerequisites: MA 661, PY 601

Corequisite: PY 602

This course treats the theoretical description of the phenomena of mechanics relating to noninertial frames of reference, with applications to space travel and the instrumentation problems of rocketry. Applications to inertial guidance and electromagnetic-inertial guidance and electromagnetic-inertial coupling effects are also considered.

Mr. Davis

PY 651 MATHEMATICS OF SOLID-STATE AND MANY-BODY THEORY

3(3-0) F

Prerequisites: MA 513, PY 502, PY 552

Topics treated include multidimensional Fourier techniques, Schwartz distributions, Green's functions, Brillouin zones, Fermi surfaces, correlation coefficients, Patterson functions and dispersion relations.

Mr. Hall

PY 652 COOPERATIVE PHENOMENA IN SOLIDS

3(3-0) S

Prerequisite: PY 651

Classical and quantum theories of equilibrium and transport properties of ferromagnetism, antiferromagnetism and order-disorder in alloys. Statistical mechanics of, and phase transitions in, these and other systems are treated.

Mr. Hall

PY 655 (MA 655) MATHEMATICS OF ASTRODYNAMICS I

3(3-0) F

(See Mathematics, page 182.)

PY 656 (MA 656) MATHEMATICS OF ASTRODYNAMICS II

3(3-0) S

(See Mathematics, page 182.)

PY 695 SEMINAR

1(1-0) FS

Reports on topics of current interest in physics. Several sections are offered so that students with common research interests may be grouped together.

Graduate Staff

PY 699 RESEARCH**Credits Arranged**

Graduate students sufficiently prepared may undertake research in some selected field of physics.

Graduate Staff**PHYSIOLOGY PROGRAM****GRADUATE FACULTY**

Professors: HENRY W. GARREN, LEMUEL GOODE, CHARLES H. HILL, ERNEST HODGSON, MORLEY R. KARE, LESTER C. ULBERG; *Associate Professors:* ALASTAIR M. STUART, ROBERT T. YAMAMOTO

Graduate study under the direction of the faculty for physiology may lead to the Master of Science and the Doctor of Philosophy degrees. The faculty for the program is interdepartmental. For students in the program, a comparative approach to the study of problems in physiology is emphasized. Experimental subjects range from insects and small rodents, to small and large domestic animals. Research laboratories and resources are available for studies, in depth, on specific physiological systems using specific species.

Majors in the program usually have a minor in either biochemistry, genetics, statistics or in a related discipline. A strong basic knowledge in one of these areas is essential.

COURSES

ANS 604 EXPERIMENTAL ANIMAL PHYSIOLOGY
 PO 524 (ZO 524) COMPARATIVE ENDOCRINOLOGY
 ZO 513 COMPARATIVE PHYSIOLOGY
 ZO 614 ADVANCED CELL BIOLOGY

OTHER SUPPORTING COURSES AVAILABLE

ENT 611 BIOCHEMISTRY OF INSECTS
 GN 532 (ZO 532) BIOLOGICAL EFFECTS OF RADIATION
 GN 633 PHYSIOLOGICAL GENETICS
 ZO 510 ADAPTIVE BEHAVIOR OF ANIMALS

PLANT PATHOLOGY**GRADUATE FACULTY**

Professor DON E. ELLIS, *Head*

Professors: JAY L. APPLE, ROBERT AYCOCK, CARLYLE N. CLAYTON, WILLIAM E. COOPER, CHARLES B. DAVEY, TEDDY T. HEBERT, GEORGE B. LUCAS, LOWELL W. NIELSEN, CHARLES J. NUSBAUM, NATHANIEL T. POWELL, JOHN P. ROSS, JOSEPH N. SASSER, HEDWIG H. TRIANTAPHYLLOU, NASH N. WINSTEAD; *Visiting Professor:* FREDERICK L. WELLMAN; *Adjunct Professors:* GEORGE H. HEPTING, ROBERT G. OWENS; *Professor Emeritus:* SAMUEL G. LEHMAN; *Associate Professors:* KENNETH R. BARKER, ELLIS

B. COWLING, GUY V. GOODING, JR., CHARLES S. HODGES, JR., SAMUEL F. JENKINS, JR., DAVID M. KLINE, ROBERT T. SHERWOOD, DAVID L. STRIDER; *Assistant Professors*: LARRY F. GRAND, DONALD HUISINGH, CHARLES E. MAIN, ROBERT D. MILHOLLAND, ROYALL T. MOORE, RONALD E. WELTY; *Adjunct Assistant Professors*: JEROME W. KOENIGS, ELMER G. KUHLMAN

The Department of Plant Pathology offers programs leading to both the Master of Science and Doctor of Philosophy degrees. Strong foundation courses in mathematics, biology, chemistry, physics and soil science are usually prerequisite for admission to candidacy for the Ph.D. degree.

The principal objective of graduate education in plant pathology is to develop the student's ability to conduct independent research which leads to the development of new knowledge. There are many opportunities for employment, especially in research, extension and teaching at land-grant colleges and experiment stations. The United States Department of Agriculture and industry also conduct programs which utilize plant pathologists. The rapid development of agricultural chemicals for disease control offers numerous opportunities in research, promotion and service. Plant pathologists also may participate in foreign service through international and federal organizations, as well as in commercial enterprises.

In addition to excellent facilities for training in general phytopathology, separate, fully equipped laboratories for research in nematology, virology, physiology of pathogenesis and special biochemical problems are available to the student. In-depth training is available in all of these particular areas.

The department has excellent greenhouse facilities and controlled environmental studies will be possible in the new Phytotron which will be available in 1968. Student participation in the Plant Disease Clinic provides excellent training and experience in the diagnosis of all types of plant diseases.

The wide range of soil types and climatic areas in North Carolina makes possible the commercial production of a variety of field, vegetable and ornamental crops, as well as forest trees. Special facilities for experimental work on diseases of these crops are available at some 16 permanent research stations located throughout the state.

The department has a number of graduate fellowships and assistantships at stipends adjusted to the previous training and experience of the recipients. These have included commercial assistantships and fellowships, National Science Foundation Traineeships, National Defense Education Act fellowships, National Aeronautics and Space Agency fellowships, E. G. Moss fellowships, and Agricultural Foundation and departmental assistantships. Students applying for fellowships from the National Science Foundation, the National Institutes of Health and other granting agencies are invited to specify the department as host institution.

FOR GRADUATES AND ADVANCED UNDERGRADUATES

PP 500 ADVANCED PLANT PATHOLOGY

3(2-3) S

Prerequisite: PP 315 or equivalent

An advanced study of the economic importance, symptoms, disease cycles, epiphytology and control of major groups of plant diseases.

Messrs. Jenkins, Kline

PP 503 DIAGNOSIS OF PLANT DISEASES

3(1-4) Sum.

Prerequisites: One advanced course in plant pathology, consent of instructor

A study of techniques used in plant disease diagnosis with emphasis on diagnostic value of signs and symptoms for certain types of diseases. Consideration will be given to major sources of descriptive information on plant pathogens and the use of keys for the identification of fungi. (Offered summer of 1968 and alternate years.)

Mr. Hodges

PP 575 (BO 575, MB 575) THE FUNGI

4(3-3) S

(See Botany, page 72.)

FOR GRADUATES ONLY**PP 601 PHYTOPATHOLOGY I**

4(2-6) F

Prerequisites: PP 315, consent of instructor

A study of the principles of phytopathological research. The course is designed to apply the classical scientific method to disease investigation. Exercises will include appraising disease problems, reviewing literature, laboratory and greenhouse experiments, and the evaluation and presentation of data.

Mr. Jenkins

PP 602 PHYTOPATHOLOGY II

4(2-6) S

Prerequisites: PP 315, consent of instructor

The basic concepts of the etiology, pathology, epiphytology and control of plant diseases.

Mr. Nusbaum

PP 604 PLANT PARASITIC NEMATODES

2(1-3) F

Prerequisite: PP 315

A study of morphology, anatomy, physiology and taxonomy of plant parasitic nematodes. Methods of isolating nematodes from soil and plant parts and other laboratory techniques used in the study and identification of nematodes will be considered.

Mrs. Triantaphyllou

PP 605 PLANT VIROLOGY

3(1-6) F

Prerequisites: GN 411, PP 315, a course in organic chemistry

A study of plant viruses including effects on host plants, transmission, classification, methods of purification, determination of properties, chemical nature, structure and multiplication. (Offered 1967-68 and alternate years.)

Mr. Hebert

PP 608 HISTORY OF PHYTOPATHOLOGY

1(1-0) F

Prerequisites: PP 315, consent of instructor

Development of the science of phytopathology from its early beginnings to the early part of the twentieth century. (Offered 1967-68 and alternate years.)

Mr. Ellis

**PP 609 CURRENT PHYTOPATHOLOGICAL RESEARCH UNDER
FIELD CONDITIONS**

2(1-3) S

Prerequisite: Graduate standing

Study of concepts involved, procedures used and evaluation made in current phytopathological research by plant pathology staff. Visits to various research stations will be made by the class.

Mr. Clayton

PP 611 NEMATODE DISEASES OF PLANTS

3(1-4) S

Prerequisite: PP 604

A study of plant diseases caused by nematodes. Special consideration will be given to host-parasite relationships, host ranges and life cycles of the more important economic species. Principles and methods of control will be considered.

Mr. Sasser

PP 612 PLANT PATHOGENESIS

3(2-3) F

Prerequisites: PP 500, consent of instructor

A study of interactions of pathogens and susceptible plants. The following major topics will be considered: hydrolytic enzyme systems involved in tissue disintegration; role of enzymes, polysaccharides and toxins in wilting phenomena; mode of action of toxins in altering plant metabolism, role of growth regulators in hypertrophic responses; alterations in respiration and other physiological processes during pathogenesis; and nature and biochemical basis for disease resistance. (Offered 1968-69 and alternate years.)

Mr. Huisingh

PP 614 FUNDAMENTALS OF NEMATODE BIOLOGY

3(2-3) F

Prerequisite: PP 604

A study of the cytology, genetics, physiology and ecology of nematodes with emphasis on plant-parasitic forms. Exercises will include cytological, physiological and biochemical techniques and will extend to limited laboratory and greenhouse experiments. (Offered in 1968-69 and alternate years.)

Messrs. Barker, Triantaphyllou

PP 690 SEMINAR IN PLANT PATHOLOGY

1(1-0) FS

Prerequisite: Consent of seminar chairman

Discussion of phytopathological topics selected and assigned by seminar chairman.

Graduate Staff

PP 699 RESEARCH IN PLANT PATHOLOGY

Credits Arranged

Prerequisites: Graduate standing, consent of instructor

Original research in plant pathology.

Graduate Staff

POLITICS

GRADUATE FACULTY

Professor WILLIAM J. BLOCK, Head

Professors: FRED V. CAHILL, JR., JOHN T. CALDWELL, PRESTON W. EDSALL, ABRAHAM HOLTZMAN; Associate Professor: KEITH S. PETERSEN; Assistant Professor: HARVEY G. KEBSCHULL

The Department of Politics offers a program of graduate studies leading to a Master of Arts degree.

A candidate for admission to this program must have demonstrated an aptitude for graduate study in politics; he may also be required to take certain further undergraduate courses to make up any deficiencies that may exist in his record.

Each student will be required to complete 30 hours of graduate work. Eighteen to 21 of these, including three hours of thesis, will be in two major fields in the Department of Politics. Major fields are to be selected from the following: political theory, American politics, comparative politics, international relations and public administration. Nine to 12 hours will be in a minor field outside the Department of Politics, which may be concentrated wholly in one related discipline or distributed among several departments. In either case a student's work in his minor field must constitute a unified pattern and must contribute to one or both of his major fields. Each student will be assigned to a graduate committee chairman for the preparation of his program of study which shall be subject to the approval of two other committee members, including one from outside the Department of Politics.

Scope and Method of Politics (PS 509) is required of every candidate for a master's degree. In addition to this particular course, the candidate must: demonstrate reading proficiency in one modern language (normally German, French, Spanish or Russian); write a thesis in one of his major areas; and take a comprehensive written examination in his major fields and an oral examination on his thesis and the major field in which it is written and on his minor.

FOR ADVANCED UNDERGRADUATES

PS 401 AMERICAN PARTIES AND PRESSURE GROUPS 3(3-0) F

After a brief survey of those features of American government essential to an understanding of the political process, the course proceeds to examine the American electorate and public opinion and devotes its major attention to the nature, organization and programs of pressure groups and political parties and to their efforts to direct opinion, gain control of government and shape public policy. Special attention is given to party organization and pressure group activity at the governmental level and to recent proposals to improve the political party as an instrument of responsible government.

PS 406 PROBLEMS IN STATE GOVERNMENT 3(3-0) S

Prerequisite: PS 201 or consent of instructor

Selected problems arising from the operation of legislative, administrative and judicial machinery. In addition to acquiring a comprehensive view of these problems each student will make an intensive study of a special phase of one of them. Special attention will be given to North Carolina.

PS 431 INTERNATIONAL ORGANIZATION 3(3-0) F

Prerequisite: PS 201 or consent of instructor

A study of the evolving machinery and techniques of international organization in the present century with particular emphasis on recent developments. The actual operation of international organization will be illustrated by the study of selected current international problems.

PS 442 GOVERNMENT AND PLANNING 3(3-0) S

Prerequisite: PS 201 or consent of instructor

A study of the planning function at all levels of government in the United

States, with particular attention to the problems posed for planning by the rapid growth of metropolitan areas.

PS 461 PUBLIC OPINION IN DEMOCRACIES

3 (3-0) S

Prerequisite: PS 201

The course is designed to develop a knowledge of the nature of public opinion and its functions in a democratic system of government. It focuses primarily on public opinion in the United States but also makes comparisons with other nations. The areas of emphasis are: theories concerning opinion formation and functions, public opinion research methodology, public opinion and policy development, and empirical studies on public opinion.

PS 471 LATIN AMERICA IN WORLD AFFAIRS

3 (3-0) F

Prerequisite: PS 376 or consent of instructor

This course examines the role of the Latin American states in world affairs, as individual states and as a region acting through international organizations. Attention is given to the historical, political, economic, social and geographic forces conditioning the foreign policies of these countries. Emphasis is placed on the relations of the Latin American countries with the United States.

PS 485 AMERICAN POLITICAL THOUGHT

3 (3-0) S

A study of the evolving currents and cross-currents of political thought that have helped to shape or to explain the actions of leaders and people from the Puritans to the New Frontiersmen, from John Winthrop and Roger Williams to John Dewey and J. K. Galbraith.

PS 491, 492 SEMINAR IN POLITICS

3 (3-0) FS

Emphasizing intensive independent work on selected topics, this seminar stresses familiarity with the literature and other resources of political science and further develops the student's skills in the methodology of the discipline.

PS 496 GOVERNMENTAL INTERNSHIP AND SEMINAR

3-6 S

Prerequisites: Junior standing, consent of the committee of selection

Governmental internship involving formal seminars; lecture-discussions by political scientists, legislators, executives, judges, representatives of special interests and news media; four to six hours a day working on assignment to and under supervision of legislators or executives; formal report at completion of an internship covering the various aspects of the program.

FOR GRADUATES AND ADVANCED UNDERGRADUATES

PS 500 POLITICAL THOUGHT: PLATO TO THE REFORMATION

3 (3-0) F

Prerequisite: PS 201 or consent of instructor

The emergence and development of the theories underlying or explaining the political aspects of behavior, approached through the study of the writings of the principal political philosophers from the days of the Greek city-state to the Reformation.

Graduate Staff

PS 501 MODERN POLITICAL THEORY

3 (3-0) S

Prerequisite: PS 201 or consent of instructor

A study of the state and its relationship to individuals and groups, approached through reading of selected passages from the works of outstanding philosophers from the Sixteenth century to the present.

Mr. Holtzman

PS 502 PUBLIC ADMINISTRATION**3(3-0) FS****Prerequisite:** PS 201 or consent of instructor

A study of the factors which contribute to goal displacement in public agencies and the institutions, concepts and techniques which may be used in such agencies to reduce the effects of these factors.

Mr. Block**PS 509 SCOPE AND METHOD OF POLITICS****3(3-0) F****Prerequisite:** PS 201 or consent of instructor

This course reviews contemporary theories, concepts and methods fundamental to the study of politics. It emphasizes current empirical research and the collateral involvement in research activities aimed at the development of basic skills in this area.

Graduate Staff**PS 510 (EC 510) PUBLIC FINANCE****3(3-0) F**

(See Economics, page 101.)

PS 512 AMERICAN CONSTITUTIONAL THEORY**3(3-0) F****Prerequisite:** PS 201 or consent of instructor

Basic constitutional doctrines, including fundamental law, judicial review, individual rights and political privileges, and national and state power. Special attention is given to the application of these doctrines to the regulation of business, agriculture and labor and to the rights safeguarded by the First, Fifth, and Fourteenth Amendments to the Constitution.

Graduate Staff**PS 521 PROBLEMS IN URBAN AND METROPOLITAN AREA GOVERNMENT** **3(3-0) S****Prerequisite:** PS 202 or consent of instructor

This course examines theory and research on problems affecting governments in metropolitan areas. Principal attention is given to those problems which effect (or result from) governmental structure, institutions and politics and to the alternative approaches to their solution.

Graduate Staff**PS 531 THE LEGISLATIVE PROCESS****3(3-0) S****Prerequisite:** PS 201 or consent of instructor

A study of the formulation of public policy from the institutional and behavioral viewpoints. Important current legislative problems at the congressional and state legislative levels will be selected and will serve as a basis for analyzing the legislative process.

Mr. Holtzman**PS 532 THE CHIEF EXECUTIVE****3(3-0) F****Prerequisite:** PS 201 or consent of instructor

This course will focus upon three major concepts of the office of the chief executive, as developed under several incumbents. First are the institutions which surround that office and which facilitate the expansion of its power and operations. Next are the various roles, which are played with more or less success by different chief executives. Last are the processes of leadership by which the chief executive can attempt to direct the machinery of government to achieve predetermined objectives.

Mr. Block**PS 533 THE JUDICIAL PROCESS****3(3-0) S****Prerequisite:** PS 201 or consent of instructor

A comparative examination of the judicial process in the United States, England and France. After a brief examination of the nature and main categories of law, the course will cover such matters as staffing of courts, the participants in litigation, the American judicial system, special consideration of the role of the

U. S. Supreme Court, court systems in the countries listed above and finally a thorough examination of judicial review in action. Administrative tribunals will receive some attention. Graduate Staff

PS 572 SEMINAR IN COMPARATIVE POLITICS

3(3-0) FS

Prerequisite: One course in comparative politics

This seminar will open with a survey of the problems and methods of comparative political analysis, after which students will be assigned a specific, limited subject to be examined within the framework of a systematic, analytical scheme appropriate to the topic. Specific topics will be drawn from the subjects of political ideologies, political groups, political elites, and decision-making institutions and processes. Graduate Staff

FOR GRADUATES ONLY

PS 601 SEMINAR IN PARTY AND GROUP POLITICS

3(3-0) S

Prerequisites: PS 401, consent of instructor

This course examines in depth such problems as mobilization of consent, recruitment of leaders, financing and conduct of campaigns, nomination processes, interparty and intraparty politics, party-interest group relations and ideology, and party-interest group relations with government and public policy. Short research papers will be required, some of which will be presented and evaluated in class. Mr. Holtzman

PS 602 SEMINAR IN LEGISLATIVE PROBLEMS

3(3-0) S

Prerequisite: Graduate standing, consent of instructor

This seminar considers basic problems characteristic of American legislative systems: development and maintenance of formal and informal rules of the game; relationships between outside inputs (by parties, interest groups, constituents, executives, courts) and legislators; strategies and tactics of leadership; committee decision-making, roles and role behavior of legislators; bicameral and apportionment problems. Each student is required to do extensive reading, to interview legislators and those who seek to influence them, and to prepare reports. Mr. Holtzman

PS 603 SEMINAR IN ADMINISTRATIVE PROBLEMS

2-4 S

Prerequisite: PS 502 or equivalent

An advanced course in administrative principles and methods. Students will perform individual or group research, under supervision, in specific administrative topics within the context of those public agencies which function in their respective fields of technology. Mr. Block

PS 604 SEMINAR IN JUDICIAL PROBLEMS

3(3-0) F

Prerequisites: Graduate standing, PS 533 or equivalent

Building on previously acquired familiarity with the judicial process, this course requires the student to work in depth on one or more contemporary judicial problems and to use various research techniques in his study. Graduate Staff

PS 621 SEMINAR IN INTERNATIONAL POLITICS

3(3-0) F

Prerequisites: Graduate standing, consent of instructor

Examination in depth of selected theories, practices and problems of international politics. Mr. Petersen

PS 696 SEMINAR IN POLITICS**2-4 F****Prerequisite:** Advanced graduate standing

An independent advanced research course in selected problems of government and politics. The problems will be chosen in accordance with the needs and desires of the students registered for the course.

Graduate Staff

PS 699 RESEARCH IN POLITICS**Credits Arranged FS****Prerequisites:** Graduate standing, consent of advisor

Research for and writing of master's thesis.

Graduate Staff

POULTRY SCIENCE**GRADUATE FACULTY***Professor* HENRY W. GARREN, *Head*

Professors: CLIFFORD W. BARBER, FRANK R. CRAIG, EDWARD W. GLAZENER, CHARLES H. HILL, MORLEY R. KARE; *Associate Professors:* WILLIAM L. BLOW; HARVEY L. BUMGARDNER, WILLIAM E. DONALDSON, PAT B. HAMILTON; *Assistant Professors:* JIMMY D. GARLICH, BURTON J. LANG

ASSOCIATE MEMBER OF THE DEPARTMENT*Professor:* DANIEL FROMM

The Department of Poultry Science offers the Master of Science degree in poultry science and doctoral programs in physiology, genetics and nutrition.

The department occupies Scott Hall, a building containing well-equipped research laboratories, animal rooms, a library and offices. Additional research facilities are located on the University farms and on three outlying farms in the western, Piedmont and eastern sections of North Carolina. New facilities for basic and applied research are under construction, both on campus and on the University farms. The research program is comprehensive and ranges from fundamental biochemical, physiological and genetic investigations to poultry management problems.

The demand for men and women with advanced training in poultry science is far greater than the supply. Many opportunities, both domestic and foreign, exist for graduates. These include research and teaching positions in public and private institutions, civil service and industry.

FOR ADVANCED UNDERGRADUATES**PO 401 POULTRY DISEASES****4(3-2) S**

The major infectious, noninfectious and parasitic diseases of poultry are studied with respect to economic importance, etiology, susceptibility, dissemination, symptoms and lesions. Emphasis is placed upon practices necessary for the prevention, control and treatment of each disease.

Mr. Craig

PO 402 COMMERCIAL POULTRY ENTERPRISES**4(3-2) S**

Principles of incubation of chicken and turkey eggs; hatchery management; organization and development of plants for the operation and maintenance of

a commercial poultry farm for meat and egg production; study of the types of buildings, equipment and methods of management currently employed by successful poultrymen in North Carolina. Mr. Brown

PO 404 (FS 404) POULTRY PRODUCTS 3(2-3) F
Prerequisite: BS 100, CH 101

Selection, processing, grading and packaging poultry meat and eggs. Factors involved in preservation of poultry meat and eggs.

PO 490 POULTRY SEMINAR 1(1-0) FS

Current topics and problems relating to poultry science and to the poultry industry are assigned for oral reports and discussion. Staff

FOR GRADUATES AND ADVANCED UNDERGRADUATES

PO 520 (GN 520) POULTRY BREEDING 3(2-2) F
Prerequisite: GN 411

Application of genetic principles to poultry breeding, considering physical traits and physiological characteristics—feather patterns, egg production, hatchability, growth, body conformation and utility. Mr. Blow

PO 521 POULTRY NUTRITION 3(2-3) F
Prerequisite: CH 220 or CH 221

A study of energy, protein, carbohydrate, fat, mineral and vitamin requirements for maintenance, growth and productive purposes. Emphasis will be on the nutritive requirements of the avian species, but the comparative aspects of nutrition will also be discussed. Carbohydrate, fat and amino acid digestion and metabolism will be presented in relation to nutritive requirements.

Mr. Donaldson

PO 524 (ZO 524) COMPARATIVE ENDOCRINOLOGY 4(3-3) S
Prerequisite: ZO 421 or ZO 414

Study of the endocrine system with respect to its physiological importance to metabolism, growth and reproduction. Mr. Garren

FOR GRADUATES ONLY

PO 602 ADVANCED POULTRY NUTRITION 3(0-6)
Prerequisites: PO 521, CH 551 or equivalent

Students taking this course will conduct a research problem in poultry nutrition. The problem will involve the designing and carrying out of chick experiments based on biochemical considerations. The students will obtain practice in designing nutritional experiments to obtain insight into biochemical problems. Mr. Hill

PO 698 SPECIAL PROBLEMS IN POULTRY SCIENCE Maximum 6 FS
Prerequisite: Graduate standing

Specific problems of study are assigned in various phases of poultry science. Graduate Staff

PO 699 POULTRY RESEARCH Credits Arranged FS
Prerequisite: Graduate standing

A maximum of six credits is allowed towards a master's degree.

Appraisal of present research; critical study of some particular problem

involving original investigation. Problems in poultry breeding, nutrition, disease, endocrinology, hematology or microbiology. Graduate Staff

PSYCHOLOGY

GRADUATE FACULTY

Professor HOWARD G. MILLER, *Head*

Professors: JOHN O. COOK, HAROLD M. CORTER, JOSEPH C. JOHNSON, SLATER E. NEWMAN; *Professor Emeritus*: KEY L. BARKLEY; *Associate Professors*: JAMES L. COLE, JOSEPH W. CUNNINGHAM, DONALD W. DREWES, ROBERT E. LUBOW, RICHARD G. PEARSON, PAUL J. RUST; *Adjunct Associate Professor*: GILBERT GOTTLIEB; *Assistant Professors*: GERALD S. LEVENTHAL, THOMAS E. LEVERE, JOHN WASIK, BERT W. WESTBROOK; *Adjunct Assistant Professor*: RONALD W. OPPENHEIM

The Department of Psychology offers courses of study leading to the Master of Science and Doctor of Philosophy degrees. Specialization in animal behavior, human factors, learning, physiological psychology, social psychology, school psychology and human resource development is available. All courses of study are designed to provide the student with solid grounding in the basic areas of psychology. A set of required core courses includes the study of learning, cognition, perception, motivation, social behavior, personality, statistics, research methodology and the philosophy of science.

Specialization in animal behavior, human factors, learning, physiological psychology and social psychology emphasize the development of proficiency in experimental methodology. Human resource development is concerned with research on human performance in vocational and educational settings. School psychology prepares for professional competence in the practice of school psychology and associated research.

A minimum of 30 semester hours of graduate credit is required for the master's degree. Though no minimum number of additional hours is required for the doctoral degree, the student may expect to take 30 or more additional semester hours of graduate credit. In any case, both for master's and doctoral candidates, the actual graduate program for each student is determined on the basis of his individual needs, interests and accomplishments.

Admission requirements for the beginning graduate student in the Department of Psychology are training in: experimental psychology and in mathematics and statistics; satisfactory grades in all undergraduate work and at least a "B" average in undergraduate psychology courses; satisfactory scores on the Graduate Record Examination (including the advanced test in psychology) and the Miller Analogies Test; and three satisfactory letters of recommendation in regard to quality of work and character. In some cases, provisional acceptance is granted where some of the requirements are not met. Admission requirements for students already possessing the master's degree who wish to obtain the doctorate in psychology are: a minimum of a "B" average in their graduate work and a substantial background in psychology or related fields; satisfactory grades in undergraduate studies; satisfactory scores on the Graduate Record Examination (including the advanced test in psychology) and the Miller Analogies Test;

and three satisfactory letters of recommendation in regard to quality of work and character.

The physical facilities for the training of graduate students in psychology include laboratories for the study of animal behavior, human learning and cognitive processes, perceptual and motor skills, environmental stress, social interaction and psychological testing and for statistical analysis.

In addition to teaching and basic research activities, faculty members of the Department of Psychology carry out research for industrial, military and other organizations. Basic and applied research projects are supported by the National Institute of Mental Health, the National Institute of Child Health and Human Development, the U. S. Office of Education, the National Science Foundation and the National Aeronautics and Space Administration. The Department of Psychology is closely associated with the Center for Occupational Education, a campus center having responsibility for conducting and coordinating extensive research activities in fields related to occupational education. The Department of Psychology also maintains close ties with Dorothea Dix Hospital, a state mental hospital in Raleigh, with the Rehabilitation Division of the North Carolina Commission for the Blind and with the Division of Research of the North Carolina Department of Mental Health which conducts basic and applied research in fields related to mental health.

Research and teaching assistantships and fellowships are available to qualified graduate students. The assistantships are usually based on one-third time assignments but are occasionally for one-half time.

FOR ADVANCED UNDERGRADUATES

PSY 411 SOCIAL PSYCHOLOGY 3(3-0) S
Prerequisite: PSY 200

The individual in relation to social factors. Socialization, personality development, communication, social conflict and social change.

Messrs. Leventhal, Miller

PSY 438 INDUSTRIAL PSYCHOLOGY II 3(3-0) S
Prerequisites: PSY 200, PSY 337

The application of psychological principles to the problems of modern industry; with particular emphasis on human relations and supervision.

Messrs. Cunningham, Miller

PSY 441 (IE 441) HUMAN FACTORS IN EQUIPMENT DESIGN 3(2-2) S
Prerequisite: IE 352 or PSY 337 or EC 426 or consent of instructor

An introduction to methodology in laboratory research, equipment design, anthropometry, and accident study. Man's sensory, motor and decision-making abilities are related to problems of systems design, operator efficiency, and safety as these involve displays, controls, workplace layout, and environment stressors.

Mr. Pearson

PSY 475 CHILD PSYCHOLOGY 3(3-0) S
Prerequisite: PSY 200 or PSY 304

The development of the individual child of elementary school age will be the inclusive object of study in this course. Emphasis will be placed upon the intellectual, social, emotional and personality development of the child. Physical growth will be emphasized as necessary for an understanding of psychological development.

Staff

PSY 476 PSYCHOLOGY OF ADOLESCENCE**2(2-0) FS****Prerequisite:** PSY 200

Nature and source of the problems of adolescents in western culture; emotional, social, intellectual and personality development of adolescents. **Mr. Johnson**

PSY 491, 492 SEMINAR IN PSYCHOLOGY**3(0-3) FS****Prerequisites:** Senior standing, consent of department

This course is designed to provide the undergraduate psychology major with skill in designing and conducting independent research studies; knowledge of sources and skill in locating information pertaining to behavior; knowledge of major trends in selected areas of study; knowledge of the research techniques available to the psychologist; knowledge of the organization of psychology as a profession; and an understanding of the code of ethics for psychologists.

Staff**FOR GRADUATES AND ADVANCED UNDERGRADUATES****PSY 500 PERCEPTION AND COGNITION****3(2-2) S****Prerequisite:** Graduate standing

The first half of the course will be a summary and analysis of the major classes of variables affecting sensation and perception. The data will be examined in the context of the development of theories of perception with emphasis on the general problem of scientific method and theory construction as well as the specific content of perceptual theory. The second half of the course will summarize and analyze the major modes of thinking and the variables affecting the thinking process. Special emphasis will be placed on the relationship between perception and thinking, and a number of the theories of thinking will be evaluated.

Graduate Staff**PSY 502 PHYSIOLOGICAL PSYCHOLOGY****3(3-0) F****Prerequisites:** Twelve hours of psychology, including PSY 200, PSY 300, PSY 310

A survey of the physiological bases of behavior including the study of co-ordination, sensory processes, brain functions, emotions and motivation.

Mr. Levere**PSY 503 COMPARATIVE PSYCHOLOGY****3(3-0) S****Prerequisites:** BS 100, PSY 310, or consent of instructor

Covers the history of the study of the comparative behavior of organisms; methodological and theoretical problems peculiar to comparative psychology, with emphasis on the ontogeny and evolution of behavior in vertebrate animals.

Mr. Gottlieb**PSY 504 ADVANCED EDUCATIONAL PSYCHOLOGY****3(3-0) S****Prerequisite:** Six hours in psychology

A critical appraisal of current psychological findings that are relevant to educational practice and theory. **Mr. Johnson**

PSY 510 LEARNING AND MOTIVATION**3(3-0) F****Prerequisite:** Graduate standing

A systematic analysis of some of the major classes of variables determining behavioral change. Learning variables are analyzed within their primary experimental setting, and emphasis is upon the diversity of the functions governing behavior change rather than upon the development of some comprehensive

theory. Both learning and motivational variables are examined as they contribute to changes in performance within the experimental setting.

Messrs. Cole, Newman, Pearson

PSY 514 LOGICAL FOUNDATIONS OF BEHAVIORAL ANALYSIS 3(3-0) F

Prerequisite: Graduate standing in psychology

An analysis of fundamental considerations involved in the formulation and verification of theories of behavior. Such topics as operationalism, formalism, reductionism, logical analysis and the nature of truth in empirical sciences will be introduced and related to research in various areas of psychological interest. The objectives are to provide insight into the nature of scientific research, to foster capability to derive testable hypotheses and to promote effective writing and speaking about psychological theory and experimentation.

Messrs. Cook, Drewes

PSY 520 PERSONALITY AND SOCIAL PSYCHOLOGY 3(3-0) F

Prerequisite: Graduate standing

An analysis of the individual and the social systems in which he operates. Systems and concepts of personality, the problem of human variability, the development of personality structure and dynamics, and of human motivation will be considered. The organization of the individual's perception and attitude structure and their relation to his social roles and group memberships will be examined. Processes of conformity, social influence and socialization will also be studied.

Messrs. Corter, Leventhal

PSY 530 ABNORMAL PSYCHOLOGY 3(3-0) S

Prerequisites: PSY 200, PSY 302

A study of the causes, symptomatic behavior and treatment of the major personality disturbances. Emphasis will be placed on theory, experimental psychopathology and preventive measures.

Mr. Corter

PSY 531 MENTAL DEFICIENCY 3(3-0) S Sum.

Prerequisites: Nine hours in psychology and special education

This will be a course in description, causation, psychological factors and sociological aspects of mental retardation. Educational methods for the mentally retarded will be examined. The course is designed primarily for school psychologists and special-class teachers of retarded children, both educable and trainable.

Mr. Corter

PSY 535 TESTS AND MEASUREMENTS 3(3-0) FS

Prerequisites: Six hours in psychology

A study of the principles of psychological testing with emphasis on test construction, interpretation of test performance and use of standard tests in research and education.

Mr. Westbrook

PSY 540 (IE 540) HUMAN FACTORS IN SYSTEMS DESIGN 3(3-0) S

Prerequisite: PSY 441 (IE 441), ST 513 or ST 515 or consent of instructor

Introduction to problems of the systems development cycle, including man-machine function allocation, military specifications, display-control compatibility, the personnel subsystem concept, and maintainability design. Detailed treatment is given to man as an information processing mechanism.

Mr. Pearson

PSY 550 MENTAL HYGIENE IN TEACHING 3(3-0) FS
Prerequisite: Six hours in psychology

A survey of mental hygiene principles applicable to teachers and pupils; practical problems in prevention and treatment of psychological problems in schools; case studies and research. Mr. Corter

PSY 565 ORGANIZATIONAL PSYCHOLOGY 3(3-0) S
Prerequisite: Nine hours in psychology

A study of the application of behavioral science, particularly psychology and social psychology, to organizational and management problems. Mr. Miller

PSY 576 DEVELOPMENTAL PSYCHOLOGY 3(3-0) F
Prerequisites: Nine hours in psychology, including PSY 475 or PSY 476

A survey of the role of growth and development in human behavior; particularly of the child and adolescent periods. This course will pay particular attention to basic principles and theories in the area of developmental psychology. Mr. Johnson

PSY 578 INDIVIDUAL DIFFERENCES 3(3-0) FS
Prerequisite: Six hours in psychology

Nature, extent and practical implications of individual differences and individual variation. Graduate Staff

PSY 591 INDIVIDUAL INTELLIGENCE MEASUREMENT 3(3-0) S
Prerequisite: PSY 520

A practicum in individual intelligence testing with emphasis on the Wechsler-Bellevue, Stanford-Binet, report writing and case studies. Mr. Corter

FOR GRADUATES ONLY

PSY 603 VERBAL LEARNING AND VERBAL BEHAVIOR 3(3-0) S
Prerequisites: PSY 510, PSY 514

This course will provide opportunity for exploration in depth of verbal-learning research studying acquisition, transfer and retention and the theories that have been proposed to explain the results of this research. Implications of findings from verbal-learning research for understanding concept learning, problem-solving and the acquisition and use of language will also be explored. Mr. Newman

PSY 604 CLASSICAL CONDITIONING 3(3-0) F
Prerequisites: PSY 510, PSY 514

The origins of classical conditioning theory and methodology will be traced from Sechenov, Bechterev and Pavlov through the recent Russian and American work. The influence of the classical conditioning paradigm on American psychology as expressed in learning theory and the conditioning therapies will be examined. Mr. Lubow

PSY 605 INSTRUMENTAL LEARNING 3(3-0) S
Prerequisites: PSY 510, PSY 514

A systematic analysis of various experimental techniques and alternative data languages for the study of instrumental learning. Primary orientation will be upon what is happening in the experimental situation rather than upon theoretical explanations of the data. Special problems, for example, discrimi-

nation, avoidance, chaining and reinforcement schedules, will be studied in depth. Various models for description of the data will be compared with special emphasis upon mathematical learning models. Mr. Cole

PSY 607 ADVANCED INDUSTRIAL PSYCHOLOGY I 3(3-0) S

Prerequisites: Nine hours in psychology and statistics or concurrent with statistics

Application of scientific methods to the measurement and understanding of industrial behavior. Messrs. Drewes, Miller

PSY 608 ADVANCED INDUSTRIAL PSYCHOLOGY II 3(3-0) F

Prerequisite: PSY 607

Application of scientific methods to the measurement and understanding of industrial behavior. Messrs. Drewes, Miller

PSY 610 THEORIES OF LEARNING 3(3-0) F or S

Prerequisites: PSY 510, PSY 514

The objectives of this course are to promote learning of the theories currently used to explain how learning and forgetting occur so that testable consequences of these theories can be derived and so that the theories and their testable consequences are capably written and spoken about. Messrs. Cole, Lubow, Newman

PSY 611 SOCIAL PSYCHOLOGY: SMALL GROUPS RESEARCH 3(3-0) S

Prerequisite: PSY 520

Factors that determine the pattern of interaction within small groups will be examined. Some factors to be considered are social norms, roles, communication networks, power and status hierarchies and types of leadership. Conformity behavior, affiliative behavior and techniques of interpersonal influence will also be analyzed. The role of interpersonal perception and individual differences in social behavior will be examined. Mr. Leventhal

PSY 635 PSYCHOLOGICAL MEASUREMENT 3(3-0) F

Prerequisites: ST 511 or equivalent, twelve hours of psychology

Theory of psychological measurement. Statistical problems and techniques in test construction. Mr. Drewes

PSY 640 (IE 640) SKILLED OPERATOR PERFORMANCE 3(3-0) F

Prerequisites: PSY 540 (IE 540) or consent of instructor

Theories of the human operator are considered with regard to the classical problems of monitoring, vigilance, and tracking. Factors such as biological rhythm, sleep loss, sensory restriction, environmental stress, and time-sharing are considered as they interact with and determine overall systems efficiency. (Offered in alternate years.) Mr. Pearson

PSY 690 SEMINAR IN INDUSTRIAL PSYCHOLOGY 3(3-0) FS

Scientific articles, analysis of experimental designs in industrial psychology and study of special problems of interest to graduate students in industrial psychology. Messrs. Cunningham, Drewes, Miller

PSY 691 SPECIAL TOPICS IN PSYCHOLOGY 1-3 FS

Prerequisite: Graduate standing, consent of instructor

Course will provide opportunity for exploration in depth of advanced topical areas which, because of their degree of specialization, are not generally involved in other courses for example multivariate methodology in psychology, com-

puter simulation, mathematical model building. Some new 600-level courses will first be offered under this title during the developmental phase and as such may involve lectures and/or laboratories. Graduate Staff

PSY 692 PERSONALITY MEASUREMENT

3(2-3) FS

Prerequisites: PSY 520, PSY 591

Theory and practicum in individual personality testing of children and adults with emphasis on projective techniques, other personality measures, report writing and case studies. Mr. Corter

PSY 693 PSYCHOLOGICAL CLINIC PRACTICUM

Maximum 12 FS

Prerequisite: Nine hours in psychology

Clinical participation in interviewing, counseling, psychotherapy and administration of psychological tests. Practicum to be concerned with adults and children. Mr. Corter

PSY 696 ADVANCED PROBLEMS IN PERCEPTION

3(2-2) F

Prerequisite: PSY 500, PSY 514

Advanced topics in perception will be the subject matter of this course. Topics will include a survey and analysis of contemporary trends in perceptual research and theory. Graduate Staff

PSY 699 RESEARCH IN PSYCHOLOGY

Credits Arranged FS

Prerequisites: Graduate standing, consent of instructor

Individual or group research problems; a maximum of six credits is allowed toward the master's degree. Graduate Staff

SOCIOLOGY AND ANTHROPOLOGY

GRADUATE FACULTY

Professor SELZ C. MAYO, Head

Professors: GLENN C. MCCANN, Graduate Administrator, C. HORACE HAMILTON; Professor Emeritus: SANFORD R. WINSTON; Associate Professors: LAWRENCE W. DRABICK, C. PAUL MARSH, CHARLES V. MERCER, HORACE D. RAWLS, JAMES N. YOUNG, ROBERT J. DOLAN, HARRY G. BEARD; Assistant Professors: B. EUGENE GRIESSMAN, MAN M. SAWHNEY

The Department of Sociology and Anthropology offers the Master of Science and the Doctor of Philosophy degrees with a major in rural sociology.

The graduate program is designed to provide the student with fundamental grounding in the basic areas of sociology. Core courses required include sociological theory, inductive statistics and sociological research methods. Students may take courses and carry out research allowing specialization in such areas as the community, social psychology, educational sociology and the sociology of rehabilitation.

The physical and educational resources of the department available to graduate students include a departmental library of bulletins, monographs and other materials consisting of several thousand items, accumulated over a period of 40 years and catalogued in indexed files. Laboratory equipment consists of calculating machines, drawing table and instruments, chart-mak-

ing materials, cameras, typewriters and statistical aids. Also at the disposal of the graduate student are automobiles for field surveys and facilities of the Computing Center.

Applicants for the graduate program are required to submit Graduate Record Examination scores (verbal and quantitative) along with other application materials. A limited number of research and teaching assistantships are available annually.

FOR GRADUATES AND ADVANCED UNDERGRADUATES

ANT 512 APPLIED ANTHROPOLOGY 3(3-0) F

Prerequisite: ANT 252 or consent of instructor

The course includes a review of the historical development of applied anthropology and a study of anthropology as applied in government, industry, community development, education and medicine. The processes of culture change are analyzed in terms of the application of anthropological techniques to programs of developmental change.

Graduate Staff

SOC 501 (ED 501) LEADERSHIP 3(3-0) FS

Prerequisite: SOC 202 or equivalent

A study of leadership in various fields of American life; analysis of the various factors associated with leadership; techniques of leadership. Particular attention is given to recreational, scientific and executive leadership procedures.

Mr. Young

SOC 502 SOCIETY, CULTURE AND PERSONALITY 3(3-0) FS

Prerequisite: SOC 202 or equivalent

Human personality is studied from its origins in primary groups through its development in secondary contacts and its ultimate integration with social norms. While comparative anthropological materials will be drawn upon, emphasis is placed upon the normal personality and the adjustment of the individual to our society and to our culture. The dynamics of personality and character structure are analyzed in terms of the general culture patterns and social institutions of society.

Mr. Rawls

SOC 504 EDUCATION IN MODERN SOCIETY 3(3-0) F

Prerequisite: Consent of instructor

An analysis of education using basic sociological concepts. Varying emphases will be placed upon the historical development of education in the United States, cross-cultural comparisons of educational structure and function, professionalization of educators, investigation of the ecological factors affecting education, effects of group processes upon learning, and the effects of social processes and changes upon the educational institution.

Mr. Drabick

SOC 505 THE SOCIOLOGY OF REHABILITATION I 3(3-0) F

Prerequisite: Graduate standing and/or consent of instructor

The area of disability and handicap is introduced from a conceptual and theoretical standpoint. Sociological and social-psychological aspects of handicaps, the rehabilitation processes, and rehabilitative organizations are stressed throughout. Particular attention is given to rehabilitation of the sociology of work in the rehabilitation processes. Socio-cultural factors in disability and handicap (residence, social class, family relationships, etc.) are analyzed in depth.

Mr. Rawls

SOC 506 THE SOCIOLOGY OF REHABILITATION II**3(3-0) S****Prerequisite:** Graduate standing and/or consent of instructor

Students will be expected to engage in individual research projects on a specific handicap, a rehabilitation process, or a rehabilitative agency or sub-agency. An attempt will be made through lectures and discussions to give the student perspective concerning the actual work of rehabilitation in process while he is pursuing his specialized interest. Emphasis will be placed on sociological methods and techniques applicable to the study of the above aspects of social behavior.

Mr. Rawls**SOC 509 POPULATION PROBLEMS****3(3-0) F****Prerequisite:** SOC 202 or equivalent

A study of population growth, rates of change and distribution. Considerable attention is given to the functional roles of population, i.e., age, sex, race, residence, occupation, marital status and education. The dynamic aspects of population are stressed: fertility, mortality and migration. Population policy is analyzed in relation to national and international goals. A world view is stressed throughout.

Graduate Staff**SOC 510 INDUSTRIAL SOCIOLOGY****3(3-0) FS****Prerequisite:** SOC 202 or equivalent

Industrial relations are analyzed as group behavior with a complex and dynamic network of rights, obligations, sentiments and rules. This social system is viewed as an interdependent part of total community life. The background and functioning of industrialism are studied as social and cultural phenomena. Specific social problems of industry are analyzed.

Graduate Staff**SOC 511 SOCIOLOGICAL THEORY****3(3-0) FS****Prerequisites:** Six hours in sociology, graduate standing or consent of instructor

Study of the interdependence of theory and method; the major theoretical and methodological systems; and examination of selected cases of research in which theory and method are classically combined.

Mr. Rawls**SOC 512 FAMILY ANALYSIS****3(3-0) F****Prerequisite:** SOC 202 or equivalent

This course examines the basic theoretical and methodological frameworks in sociology within which contemporary family research is conducted.

Graduate Staff**SOC 513 (ED 513) COMMUNITY ORGANIZATION****3(3-0) F****Prerequisite:** SOC 202 or equivalent

Community organization is viewed as a process of bringing about desirable changes in community life. Community needs and resources available to meet these needs are studied. Democratic processes in community action and principles of community organization are stressed, along with techniques and procedures. The roles of leaders, both lay and professional, in community development are analyzed.

Mr. Mayo**SOC 523 SOCIOLOGICAL ANALYSIS OF AGRICULTURAL LAND TENURE SYSTEMS****3(3-0) F****Prerequisite:** Three hours of sociology

A systematic sociological analysis of the major agricultural and land tenure systems of the world with major emphasis on the problems of family farm ownership and tenancy in the United States.

Graduate Staff

SOC 534 (HI 534) AGRICULTURAL ORGANIZATIONS AND MOVEMENTS 3(3-0) S
Prerequisites: Three hours of sociology, American history, American government or a related social science or consent of department

A history of agricultural organizations and movements in the United States and Canada principally since 1865, emphasizing the Grange, the Farmers' Alliance, the Populist revolt, the Farmers' Union, the Farm Bureau, the Equity societies, the Nonpartisan League, cooperative marketing, government programs and present problems.
Mr. Noblin

SOC 541 SOCIAL SYSTEMS AND PLANNED CHANGE 3(3-0) F
Prerequisite: Three hours of sociology

A study of social agencies and programs and their implementation through specific organizations in dynamic relation with the people whom they serve. Consideration is given to the relation of these agencies and programs to community structure and forces in society; coordination of the several types of agencies and programs, professional leadership and participation.

Graduate Staff

SOC 590 APPLIED RESEARCH 3(3-0) FS
Prerequisite: SOC 202 or equivalent

A study of the research process with particular emphasis upon its application to action problems. The development of research design to meet action research needs receives special attention.

Graduate Staff

SOC 591 SPECIAL TOPICS IN SOCIOLOGY Maximum 6 FS
Prerequisite: Consent of instructor

An examination of current problems in sociology organized on a lecture-discussion basis. The content of the course will vary as changing conditions require the use of new approaches to deal with the emerging problems.

Graduate Staff

FOR GRADUATES ONLY

SOC 611 RESEARCH METHODS IN SOCIOLOGY 3(3-0) F
Prerequisites: SOC 416, ST 311 or equivalent

Designed to give the student a mature insight into the nature of scientific research in sociology. Assesses the nature and purpose of research designs, the interrelationship of theory and research, the use of selected techniques and their relation to research designs, and the use of modern tabulation equipment in research.

Mr. McCann

SOC 621 SOCIAL PSYCHOLOGY 3(3-0) F
Prerequisites: Six hours of sociology

Treats the genetic development of the personality and the interrelationship of the individual and the society. Studies of social psychological factors related to leadership, morale, social organization and social change, and examines the attitudes and opinions of people on current local and national issues.

Mr. McCann

SOC 631 POPULATION ANALYSIS 3(3-0) S
Prerequisites: Six hours of sociology

Methods of describing, analyzing and presenting data on human populations: distribution, characteristics, natural increase, migration and trends in relation to resources.

Graduate Staff

SOC 632 SOCIOLOGY OF THE FAMILY

3(3-0) S

Prerequisites: Six hours of sociology

Emphasis is placed on the development of an adequate sociological frame of reference for family analysis; on discovering both the uniquely cultural and common-human aspects of the family by means of cross-cultural comparisons; on historical explanations for variability in American families with special concern for the family; and on analyzing patterns of family stability and effectiveness.

Graduate Staff

SOC 633 THE COMMUNITY

3(3-0) S

Prerequisites: Six hours of sociology

The community is viewed in sociological perspective as a functioning entity. A method of analysis is presented and applied to eight "dimensions," with emphasis on the unique types of understanding to be derived from measuring each dimension. Finally, the effect of change on community integration and development is analyzed.

Graduate Staff

SOC 641 (ST 641) STATISTICS IN SOCIOLOGY

3(3-0) S

Prerequisite: ST 513 or equivalent

The application of statistical methods of sociological research. Emphasis on selecting appropriate models, instruments and techniques for the more frequently encountered problems and forms of data.

Graduate Staff

SOC 652 COMPARATIVE SOCIETIES

3(3-0) S

Prerequisites: Six hours of sociology

Sociological analysis of societies around the world with particular reference to North and South America. Special emphasis is given to cultural and physical setting, population composition, levels of living, relationship of the people to the land, structure and function of the major institutions and forces making for change.

Graduate Staff

SOC 653 THEORY AND DEVELOPMENT OF SOCIOLOGY

3(3-0) S

Prerequisites: SOC 511, consent of instructor

Detailed analysis of methodological and substantive problems in utilizing sociological theories in varied areas, and an examination of events and trends in the development of sociology.

Graduate Staff

SOC 690 SEMINAR

Credits Arranged FS

A maximum of two semester hours is allowed toward the master's degree.

Appraisal of current literature; presentation of research papers by students; progress reports on departmental research; review of developing research methods and plans; reports from scientific meetings and conferences; other professional matters.

Graduate Staff

SOC 699 RESEARCH IN SOCIOLOGY

Credits Arranged FS

Prerequisite: Consent of graduate study committee chairman

Planning and execution of research, and preparation of manuscript under supervision of graduate committee.

Graduate Staff

SOIL SCIENCE**GRADUATE FACULTY***Professor RALPH J. MCCracken, Head*

Professors: JACK V. BAIRD, WILLIAM V. BARTHOLOMEW, CHARLES B. DAVEY, JAMES W. FITTS, EUGENE J. KAMPRATH, WILLIAM A. JACKSON, JAMES F. LUTZ, CHARLES B. McCANTS, PRESTON H. REID, RICHARD J. VOLK, WILLIAM G. WOLTZ, WILLIAM W. WOODHOUSE, JR.; *Associate Professors:* STANLEY W. BUOL, MAURICE G. COOK, FRED R. COX, GEORGE A. CUMMINGS, ROBERT E. MCCOLLUM, STERLING B. WEED; *Visiting Associate Professors:* ROBERT B. CATE, JR., ARVEL H. HUNTER, DONOVAN L. WAUGH; *Assistant Professors:* JAMES W. GILLIAM, CLIFFORD K. MARTIN; *Visiting Assistant Professor:* JAMES L. WALKER

The Department of Soil Science offers training leading to the degrees of Master of Science and Doctor of Philosophy in the fields of soil chemistry, soil fertility, soil physics, soil genesis, soil microbiology and soil conservation.

Modern facilities are provided for soils graduate teaching and research in William Hall. Office and laboratory space is assigned each student. Literature relative to soils and related subjects is maintained in a departmental library. Facilities for graduate research include radioactive and stable isotope laboratories containing automatic recording scalers and liquid scintillation apparatus, a mass spectrometer, amino acid analyzer, X-ray diffraction apparatus with fluorescence, differential thermal analysis, infrared spectrophotometer, atomic absorption spectrophotometer, polarizing microscope, high-speed centrifuges, thin-sectioning apparatus and other modern equipment. Photomicrographic equipment is available for photographing thin sections and microorganisms.

Service laboratories for soil and plant analyses are available as well as special preparation rooms for solid and plant samples. Greenhouses and growth chambers situated at the rear of Williams Hall are easily accessible for controlled plant studies. Field experiments are made on the 16 research farms and four experimental forests owned or operated by the state. Located throughout North Carolina, the farms and forests include a wide variety of soil and climatic conditions. One of the largest and best-equipped soil testing laboratories in the United States is operated by the North Carolina Department of Agriculture in Raleigh. Special studies on various problems of soil testing can be made in conjunction with this laboratory.

Strong supporting departments greatly increase the graduate student's opportunities for a broad and thorough training. Included among those departments in which graduate students in soil science work cooperatively or obtain instruction are crop science, biological and agricultural engineering, botany, chemistry, economics, forestry, geology, mathematics, plant pathology, physics and statistics.

FOR GRADUATES AND ADVANCED UNDERGRADUATES

SSC 511 SOIL PHYSICS

4(3-3) F

Prerequisites: PY 212, SSC 200

Physical constitution and analyses; soil structure, soil water, soil air and soil temperature in relation to plant growth.

Mr. Lutz

SSC 522 SOIL CHEMISTRY

4(3-3) S

Prerequisites: SSC 200, SSC 553, CH 433 or equivalent

A consideration of the chemical and colloidal properties of clay and soil systems, including ion exchange and retention, soil solution reactions, solvation of clays and electrokinetic properties of clay-water systems. Mr. Weed

SSC 532 (MB 532) SOIL MICROBIOLOGY

3(3-0) S

Prerequisites: CH 220, MB 401, SSC 302

The more important microbiological processes that occur in soils; decomposition of organic materials, ammonification, nitrification and nitrogen fixation.

Graduate Staff

SSC 541 SOIL FERTILITY

3(3-0) F

Prerequisites: SSC 302, SSC 341

Soil conditions affecting plant growth and the chemistry of soil and fertilizer interrelationships. Factors affecting the availability of nutrients. Methods of measuring nutrient availability. Mr. Kamprath

SSC 551 SOIL MORPHOLOGY, GENESIS AND CLASSIFICATION

3(3-0) F

Prerequisites: GY 120, SSC 200, SSC 302 or SSC 341

Morphology: Study of concepts of soil horizons and soil profiles and chemical, physical and mineralogical parameters useful in characterizing them. Genesis: Critical study of soil-forming factors and processes. Classification: Critical evaluation of historical development and present concepts of soil taxonomy with particular reference to great soil groups as well as discussion of logical basis of soil classification. Mr. Buol

SSC 553 SOIL MINERALOGY

3(2-3) F

Prerequisites: SSC 200, SSC 341, GY 331 or equivalent

Composition, structure, classification, identification, origin, occurrence and significance of soil minerals with emphasis on primary weatherable silicates, layer silicate clays and sesquioxides. Mr. Cook

SSC 560 NORTH CAROLINA SOILS AND THEIR MANAGEMENT

3(3-0) Sum.

Prerequisites: SSC 200, SSC 302 or SSC 341

Field studies of selected soil series in the coastal plain, Piedmont and mountain areas of North Carolina. Discussion of management practices that should be associated with the various soils under different types of farming. (Offered summer of 1969 and alternate years.) Messrs. Kamprath, McCracken

SSC 590 SPECIAL PROBLEMS

Credits Arranged FS

Prerequisites: SSC 200, SSC 302

Special problems in various phases of soils. Problems may be selected or will be assigned. Emphasis will be placed on review of recent and current research.

Graduate Staff

FOR GRADUATES ONLY**SSC 622 PHYSICAL AND CHEMICAL PROPERTIES OF SOILS**

4(4-0) S

Prerequisites: CH 433, SSC 511, SSC 522, MA 301 or equivalent

An examination in depth of current ideas in the field. Topics will include double-layer theory, molecular adsorption, ion exchange, diffusion of ions in soil-water systems, and relations between clay-mineral structures and their chemical properties. Mr. Weed

**SSC 632 (MB 632) ECOLOGY AND FUNCTIONS OF SOIL
MICROORGANISMS**

3(3-0) S

Prerequisites: MB 401, SSC 532 or equivalent

A comprehensive examination of theories and concepts relative to ecology and functions of soil microorganisms. Topics include relationships of microbes to their environments, adaptive mechanisms, microbial processes in soil organic matter formation and degradation, and function of organic matter in soil systems. Subject emphasis will be determined by class interests and by current literature. (Offered 1968-69 and alternate years.) Messrs. Bartholomew, Davey

SSC 651 PEDOLOGY

3(3-0) F

Prerequisites: SSC 522, SSC 511, SSC 551 or equivalent

A critical study of current theories and concepts in soil genesis and morphology; detailed study of soil taxonomy. Topics include weathering and clay mineral genesis as related to soil morphology and genesis, functional analyses of soil genesis, properties of and processes responsible for soil profiles formed under various sets of soil-forming factors, classification theory and logic as applied to soil classification, structure of soil classification schemes. Any of these topics may be emphasized, according to student interests. (Offered 1969-70 and alternate years.) Mr. McCracken

SSC 671 (BAE 671) THEORY OF DRAINAGE: SATURATED FLOW

3(3-0) S

(See Biological and Agricultural Engineering, page 69.)

SSC 672 SOIL PROPERTIES AND PLANT DEVELOPMENT

3(3-0) S

Prerequisites: BCH 551, SSC 522 or equivalent

A detailed examination of the effects of soil factors in the development of crop plants. Segments of the course will treat soil transformation processes of both organic and inorganic constituents, concepts of nutrient availability and the relation of plant development indices to specific soil properties. (Offered 1969-70 and alternate years.) Mr. Jackson

SSC 674 (BAE 674) THEORY OF DRAINAGE: UNSATURATED FLOW

3(3-0) F

(See Biological and Agricultural Engineering, page 69.)

SSC 690 SEMINAR

1(1-0) FS

Prerequisite: Graduate standing in soil science

A maximum of two semester hours is allowed toward the master's degree, but any number toward the doctorate.

Scientific articles, progress reports in research and special problems of interest to soil scientists reviewed and discussed. Graduate Staff

SSC 693 COLLOQUIUM IN SOIL SCIENCE

Credits Arranged FS

Prerequisite: Graduate standing in soil science

Seminar-type discussions and lectures on specialized and advanced topics in soil science. Graduate Staff

SSC 699 RESEARCH

Credits Arranged FS

Prerequisite: Graduate standing in soil science

A maximum of six semester hours is allowed toward the master's degree, but any number toward the doctorate. Graduate Staff

SCHOOL OF TEXTILES

GRADUATE FACULTY

Professor DAVID W. CHANEY, *Dean*

Professors: CLARENCE M. ASBILL, JR., JOHN F. BOGDAN, KENNETH S. CAMPBELL, DAVID M. CATES, *Graduate Administrator in Textile Chemistry*, DAME S. HAMBY, JOSEPH A. PORTER, JR., HENRY A. RUTHERFORD, WILLIAM E. SHINN, ROBERT W. WORK; *Associate Professors*: JAMES H. DORNBURG, THOMAS W. GEORGE, RICHARD D. GILBERT, GEORGE GOLDFINGER, THOMAS H. GUION, ARTHUR C. HAYES, SOLOMON P. HERSH, *Graduate Administrator in Textile Technology*, WILLIAM C. STUCKEY, JR.; *Assistant Professors*: BHUPENDER S. GUPTA, WILLIAM K. WALSH

The School of Textiles offers programs leading to the Master of Science degree in textile chemistry and in textile technology, the professional degree of Master of Textile Technology, and the Doctor of Philosophy in fiber and polymer science.

The fundamental objectives of the graduate program in the School of Textiles are to provide the student with a sound education in a selected field and to develop his ability to initiate and conduct independent investigations which lead to the development of new knowledge. These objectives are accomplished through programs designed to give him a foundation in the basic sciences and to develop a broad and comprehensive understanding of a major field through study and research.

Students with Bachelor of Science or Bachelor of Arts degrees with majors in the physical sciences or engineering, combined with a strong background in mathematics, will normally qualify for the graduate degree programs.

The programs of study for the Master of Science degree include a minimum of 30 semester hours of advanced courses, including a thesis based on research conducted by the student, and proficiency in one foreign language. The plan of course work and the research activities for the Master of Science degree are designed to prepare the student for a career in research, development or other technical phases of the textile and allied industries. Students may minor in any one of a number of associated fields.

The minimum requirement for a Master of Textile Technology degree is the satisfactory completion of 33 semester hours of advanced courses. There is no thesis or foreign language requirement. This program is designed to offer the student advanced professional training. Students pursuing this degree are encouraged to minor in economics with emphasis in the area of management.

Programs of study may be arranged to develop a broad background in three general areas: advanced textile technology; marketing; textile chemistry. Those students interested in the first of these may emphasize areas such as fiber and yarn technology, fabric technology, knitting technology, and testing or quality control. In the area of marketing, the program emphasizes the applications of operations research and computer techniques to the textile industry. Programs in these areas normally terminate within the School of Textiles with either the Master of Textile Technology or Master of Science degree in textile technology. Programs leading

to the Master of Science degree in textile chemistry emphasize fiber and polymer chemistry.

Fiber and polymer science is derivative from chemistry, physics and mathematics, as well as engineering, itself a derivative field. It is concerned not only with the basic material, i.e., the fiber-forming polymer but also the structures into which the basic material can be fashioned and the processes by which it can be changed. Programs of study leading to the Doctor of Philosophy degree are designed to provide a knowledge of mathematics and the physical sciences, as well as the application of engineering principles, to provide a perspective that encompasses the many interacting factors involved in the preparation and conversion of polymeric materials to useful products.

Current research activities in the Department of Textile Chemistry emphasize fiber and polymer science including studies of the physical chemistry of dyeing, color physics, polymer-solvent interactions, sorption and diffusion processes, mechanism of reactions with fibrous substrates, modification of fibrous polymers by radiation, thermal properties of polymers and polymer crystallization phenomena. In the Department of Textile Technology, research activities include fundamental studies of the formation of man-made fibers and their properties; yarn structure and properties; electrical, frictional and mechanical properties of fibers and yarns; and novel processes associated with current developments in materials and equipment.

The physical resources of the School of Textiles include all of the machines and equipment commonly used in the processing of natural and man-made fibers into yarns, woven and knitted fabrics and in their final dyeing and finishing. In addition, an unusually large variety of specialized research and testing equipment is available. These include such unique facilities as laboratories for color measurement and matching, for texturing yarns and for preparing man-made fibers. Well-equipped shop facilities and physics, electronics and instrumentation laboratories are also available in the school. A library containing specialized journals and books covering the fields of textiles, fiber and polymer science, and related subjects is conveniently housed within the school.

A number of assistantships and fellowships are available with stipends ranging from \$2,700 to \$3,600.

For a description of courses offered by the School of Textiles, see Textile Chemistry and Textile Technology, below.

TEXTILE CHEMISTRY

(For a listing of graduate faculty and other information, see Textiles, page 244.)

FOR ADVANCED UNDERGRADUATES

TC 403, 404 TEXTILE CHEMICAL TECHNOLOGY

3(3-0) FS

Prerequisites: CH 223, TC 303

The chemistry involved in the wet processing of fibrous systems, especially dyeing, printing and finishing. The course emphasizes principles and includes a study of the various classes of dyes and their application to all important

textile fibers and blends of fibers; preparatory and bleaching processes; roller printing and print formulations for important dye classes; nature and application of finishes for textiles. **Mr. Campbell**

TC 405, 406 TEXTILE CHEMICAL TECHNOLOGY LABORATORY 2(0-6) FS
Prerequisites: TC 403, TC 404

TC 412 TEXTILE CHEMICAL ANALYSIS II 3(2-3) F
Prerequisite: CH 215

Analysis of textile materials involving specialized instruments, and techniques such as spectrophotometry, pH measurements, electrometric titration, viscometry, etc.

TC 421 FABRIC FINISHING I 2(2-0) S
Prerequisite: TC 203

A general course in fabric finishing designed for students not majoring in textile chemistry. Emphasis placed on finishes used on garment-type fabrics, including stabilization finishes, water repellency, crease resistance, moth and mildew proofing, fire-proofing, etc. Emphasis on chemistry of finishes varied to fit requirements of students. **Mr. Hayes**

TC 461 (CH 461) CHEMISTRY OF FIBERS 3(3-0) S
Prerequisite: CH 223

A lecture course emphasizing the theory of fiber structure; the relationship between the chemical structure and physical properties of natural and man-made fibers; the nature of the chemical reactions which produce degradation of fibers; the production of man-made fibers. **Messrs. Gilbert, Rutherford**

TC 491 SEMINAR IN TEXTILE CHEMISTRY 1(1-0) S
Prerequisite: TC 403

The course is designed to familiarize the student with the principal sources of textile chemical literature and to emphasize the importance of keeping abreast of developments in the field of textile chemistry. Particular attention is paid to the fundamentals of technical writing. **Mr. Campbell**

FOR GRADUATES AND ADVANCED UNDERGRADUATES

TC 521 TEXTILE CHEMICAL ANALYSIS III 3(2-3) FS
Prerequisite: TC 421 or equivalent

The work includes a survey of organic chemistry, with emphasis on organic surfactants, warp sizes and fabric finishes of all types; the identification of fibers by chemical means; the qualitative and quantitative analysis of fiber blends by chemical means; the identification of finishes; the evaluation techniques for dyed and finished materials. **Graduate Staff**

TC 561 ORGANIC CHEMISTRY OF HIGH POLYMERS 3(3-0) F
Prerequisite: TC 461, CH 231 or CH 431

Principles of step reaction and addition polymerizations; copolymerization theory; emulsion polymerization; ionic polymerization; characterization of polymers; molecular structure and properties. **Mr. Gilbert**

TC 562 (CH 562) PHYSICAL CHEMISTRY OF HIGH POLYMERS—BULK PROPERTIES 3(3-0) S

Prerequisites: CH 220 or CH 223, CH 431

Kinetics and molecular weight description; states of aggregation and their interconversion; rubbery, glassy and crystalline states; diffusional properties.
Mr. Cates

FOR GRADUATES ONLY

TC 605 PHYSICAL CHEMISTRY OF DYEING 3(3-0) F
Prerequisite: CH 433

Development of principles of thermodynamics, emphasizing applications in dye and fiber chemistry.
Mr. Guion

TC 662 PHYSICAL CHEMISTRY OF HIGH POLYMERS—SOLUTION PROPERTIES 3(3-0) F
Prerequisites: CH 433, TC 562

Thermodynamics of polymer solutions; phase equilibria; methods of determining molecular weight.
Mr. Cates

TC 671 (CHE 671) SPECIAL TOPICS IN POLYMER SCIENCE 1-3 F
Prerequisite: Consent of instructor

An intensive treatment of selected topics in fiber and polymer science.
Graduate Staff

TC 698 SEMINAR FOR TEXTILE CHEMISTRY 1(1-0) FS
Discussion of scientific articles of interest to fiber and polymer science; review and discussion of student papers and research problems.
Graduate Staff

TC 699 TEXTILE RESEARCH FOR TEXTILE CHEMISTRY Credits Arranged
Problems of specific interest to the textile industry will be assigned for study and investigation. The use of experimental methods will be emphasized. Attention will be given to the preparation of reports for publication. The master's thesis may be based upon the data obtained.
Graduate Staff

TEXTILE TECHNOLOGY

(For a listing of graduate faculty and other information, see Textiles, page 244.)

FOR ADVANCED UNDERGRADUATES

TX 401 SPECIAL TOPICS IN TEXTILE TECHNOLOGY 3(3-0) FS
Prerequisites: TX 304, TX 366

This course is to expand on the trends, developments, new concepts and research results of the industry. A general orientation is toward the updating of information in these areas and the influence on the economic aspects by the factors involved. Certain aspects of marketing will be presented.
Staff

TX 430 CONTINUOUS FILAMENT YARNS 3(2-2) FS
Prerequisite: TX 301

A study of properties and processes applicable only to filament yarns such as texturizing and bulking. Detailed studies of throwing systems, engineering requirements of equipment and yarn property changes resulting from processing.
Mr. Tucker

TX 436 STAPLE FIBER PROCESSING**3(2-2) FS****Prerequisite:** TX 301

A study of special systems of processing long staple, natural and man-made fibers, including woolen, worsted, direct spinning, Turbo Stapler or Pacific Converter, and sliver to yarn methods. New concepts and research findings as applied to all yarn processes.

Mr. Pardue**TX 441 FLAT KNITTING****3(2-2) F****Prerequisite:** TX 340

A study of the leading types of flat knitting machines including warp knitting machines, design possibilities and fabric adaptability.

Mr. Shinn**TX 444 GARMENT MANUFACTURE****3(2-2) S****Prerequisite:** TX 340

A study of circular latch needle and spring needle machines for knitted fabric production. Styling, cutting and seaming of the basic garment types for underwear and outerwear; standard seam types; high-speed sewing machines.

Mr. Shinn**TX 447, 448 ADVANCED KNITTING LABORATORY****2(0-4) FS****Prerequisite:** TX 340

Systematic study of circular hosiery mechanisms; hosiery types and constructions. Seamless hosiery production methods utilizing the newer synthetic yarns, toe closing methods, finishing processes and marketing are emphasized.

Messrs. Middleton, Shinn**TX 449 TRICOT KNITTING****3(2-2) S****Prerequisite:** TX 340

A study of basic types of tricot knitting machines with emphasis on mechanisms and fabrics. Attention is given to warp preparation methods applicable to the tricot machine, the characteristics of yarn made from natural and synthetic fibers as they affect processing into warp knitted fabrics; machine settings for proper qualities and ratios; economics of warp knitting, and end uses. Attention is given to fabric design and analysis.

Mr. Shinn**TX 478 DESIGN AND WEAVING****3(2-2) FS****Prerequisite:** TX 366

Advanced study of special weave formations and the techniques and equipment necessary to form these fabrics. Studies in depth of new developments and research findings in the areas of warp preparation, design, weaving and fabric formation.

Messrs. Berry, Moser**TX 483 TEXTILE COST METHODS****3(3-0) FS****Prerequisite:** TX 302

A study of cost methods applicable to textile costing with emphasis on decision-making. Interpretation of cost reports and their use in pricing and cost control.

Messrs. King, Lynch**TX 485 MILL DESIGN AND ORGANIZATION****4(3-2) FS****Prerequisites:** TX 304, TX 366

Detailed analysis of waste losses in the textile mill and relationship to cost. Application of economic principles of textile marketing, factoring, hedging and other buying and selling problems. Organization, planning and scheduling, inventory control and departmental functions of textile companies. Automation

as applied to textile processing in grey mills. Technical problems of plant site selection, plant design and layout, and selection of equipment. Design and layout of a mill from raw fiber to grey fabric by each student.

Messrs. Dornburg, Lynch

TX 487 (EC 487) SALES MANAGEMENT FOR TEXTILES 3(3-0) S

Prerequisites: EC 205, TX 485

Definition and analysis of the role of sales management in the textile industry. Areas of control and responsibility are reviewed. Areas of analytical tools of sales management are studied and through case methods are brought into practical focus for the student.

Mr. Dornburg

TX 490 DEVELOPMENT PROJECT I 1-3 FS

Prerequisites: Senior standing, consent of instructor

A problem of independent study assigned to seniors in the major field of study serving also as the laboratory period for senior-level courses.

Staff

FOR GRADUATES AND ADVANCED UNDERGRADUATES

TX 521 TEXTILE TESTING II 3(2-2) F

Prerequisite: TX 327

Advanced techniques for measuring properties of natural and man-made fibers, yarns and fabrics. Interrelations of raw material quality, processing characteristics and end-product properties. The application of the laws of physical sciences to evaluation of textile materials.

Mr. Stuckey

TX 522 TEXTILE QUALITY CONTROL 3(2-2) S

Prerequisite: TX 521

Quality control systems for textile operations. Defect prevention methods, isolation of processes contributing to substandard quality, relationship between quality control department and operating divisions. Laboratory design, equipment and personnel selection, installation of quality control systems.

Mr. Stuckey

TX 523 MECHANICAL PROPERTIES OF FIBERS 3(2-2) F

Prerequisites: MA 301, PY 212

The course is designed to give a student advanced knowledge of the mechanical behavior and frictional, optical and electrical properties of the natural and man-made fibers.

Mr. Gupta

TX 525 ADVANCED TEXTILE MICROSCOPY 2(0-4) FS

Prerequisite: TX 327

Experiments and demonstrations in more advanced techniques of textile microscopy. Detailed studies of structures of fibers and study of all types of microscopes and their uses in textiles. Preparation of slides for photography. Uses of photomicrographic equipment.

Mr. Gupta

TX 551 COMPLEX WOVEN STRUCTURES 3(2-2) S

Prerequisite: TX 478

The development of design specifications for complex fabrics as related to fabric geometry, functional and aesthetic properties and manufacturing limitations.

Graduate Staff

TX 575 FABRIC ANALYTICS AND CHARACTERISTICS**3(3-0) FS****Prerequisite:** TX 302

Analysis and study of textile fabrics to determine the composite effects of yarn and fiber properties. Fabric design features that are related to mechanical as well as aesthetic properties. Engineering and fabrics based on utilization of other mixtures and homogeneous blends of natural and man-made fibers. Mr. Porter

TX 585 (EC 585) MARKET RESEARCH IN TEXTILES**3(3-0) S****Prerequisites:** EC 205, ST 515, TX 485

A study and analysis of the quantitative methods employed in market research in the textile industry. The function of market research and its proper orientation to management and decision-making. Mr. Dornburg

TX 590 SPECIAL PROJECTS IN TEXTILES**1-3 FS****Prerequisites:** TX 327, senior standing, consent of instructor

Special studies in either the major or minor field of the advanced undergraduate or graduate student. These special studies will take the form of current problems of the industry, independent investigations in the areas of textile testing and quality control, seminars and technical presentations, both oral and written. Graduate Staff

TX 591 SPECIAL TOPICS**1-4 FS****Prerequisite:** Consent of instructor

Faculty and student discussions of special topics in textile technology.

Mr. Dornburg

TX 598 TEXTILE TECHNOLOGY SEMINAR**2(2-0) S****Prerequisites:** Senior standing, consent of instructor

Lecture and discussion periods are designed for students who are particularly interested in yarn manufacturing aspects of the textile industry. Subject matter will include such aspects as training methods, safety programs, modern mill design, specialized techniques in setting rates, employee relations and developments that arise from technical meetings. Mr. Dornburg

FOR GRADUATES ONLY**TX 601, 602 STAPLE FIBER STRUCTURES****3(2-2) FS****Prerequisite:** Graduate standing

Studies of advanced techniques in textile production; the technological aspects of fiber properties in relation to processing; studies of research findings and application of these to processing equipment. Mr. Bogdan

TX 603 TEXTILE STRUCTURES**3(2-2) S****Prerequisites:** MA 301, PY 212, TX 521

The course is designed to give a student advanced knowledge of the structure and some physical properties of the natural and synthetic fibers, and an advanced knowledge of the structure of twisted yarns and their behavior in finished products. Mr. Gupta

TX 621 TEXTILE TESTING III**2(2-0) S****Prerequisite:** TX 522 or equivalent

Design of textile laboratories, including conditioning equipment and instruments required for specific needs; performance of tests and analysis of data on

industrial problems; specialized physical tests; interlaboratory tests and analysis; study of A.S.T.M. specifications and work on task groups for the A.S.T.M. Society. Mr. Gupta

TX 631 SYNTHETIC FIBERS 2(1-2) FS
Prerequisite: TX 430 or TX 436 or equivalent

Lectures and projects on advanced problems relative to the properties and processing of man-made continuous filament and staple fiber yarns. Mr. Hersh

TX 641, 642 ADVANCED KNITTING SYSTEMS AND MECHANISMS 3(3-0) FS
Prerequisite: TX 441 or equivalent

A critical study of inventions which have contributed to the development of the modern knitting industry; knitting needles and their adaption for specific uses; means for mounting them for individual and *en masse* operation; construction and functioning of cooperating elements including sliders, jacks, sinkers, dividers, pressing elements, narrowing and tensioning and draw-off motions, regulating mechanisms, timing and control chains and cams. Use will be made of patent literature which covers important developments in the hosiery industry. Mr. Shinn

TX 643, 644 KNITTING TECHNOLOGY 3(1-4) FS
Prerequisites: Graduate standing, eight hours in knitting technology

Problems of specific interest to the knitting industry will be assigned for study and investigation. The use of experimental methods will be emphasized. Attention will be given to the preparation of reports for publication. Graduate Staff

TX 651, 652 FABRIC DEVELOPMENT AND CONSTRUCTION 3(1-4) FS
Prerequisite: Graduate standing

Application of advanced technology to the development and construction of woven fabrics. Mr. Porter

TX 698 SEMINAR 1(1-0) FS
Discussion of scientific articles of interest to the textile industry; review and discussion of student papers and research problems. Graduate Staff

TX 699 TEXTILE RESEARCH Credits Arranged
Problems of specific interest to the textile industry will be assigned for study and investigation. The use of experimental methods will be emphasized. Attention will be given to the preparation of reports for publication. The master's thesis may be based upon the data obtained. Graduate Staff

WATER RESOURCES MINOR

(An interdepartmental, intercampus graduate program.)

WATER RESOURCES COMMITTEE — RALEIGH CAMPUS

DR. DALE M. HOOVER (Economics), *Chairman*
DR. WILLIAM J. BLOCK (Politics), DR. DOUGLAS C. CHAMBLEE (Crop Science), DR. ARTHUR W. COOPER (Botany), DR. ERIC ELLWOOD (Wood Science and Technology), DR. JAMES K. FERRELL (Chemical Engineering), DR. FRANK E. GUTHRIE (Entomology), DR. WILLIAM W. HASSLER (Zoology), DR. D. W. HAYNE (Experimental Statistics), PROF. DAVID H. HOWELLS (Water Resources Research Institute), *Secretary*, DR. J.

F. LUTZ (Soil Science), DR. V. A. JONES (Food Science), DR. T. E. MAKI (Forest Management), PROF. HENRY RUTHERFORD (Textile Chemistry), PROF. CHARLES SMALLWOOD, JR. (Civil Engineering), DR. CHARLES W. WELBY (Geosciences), DR. EDWARD H. WISER (Biological and Agricultural Engineering)

Water is a vitally important and unique resource. It is an essential ingredient of life, and civilizations have withered in its absence. The total supply is adequate; yet, variability in supply and demand create problems of scarcity and excess. Water is a renewable resource, but the intensity and multiplicity of use bring conflict and deterioration in quality. The increasing thirst of a rapidly developing land can only be met by intelligent management which takes into consideration all aspects of man's changing needs.

Water resources management is a major issue throughout the country and national policy supports strong water resources programs at all levels of government. These are multidisciplinary undertakings and require understanding of the many complex effects of conservation and development on all of society's interests. They require well-trained specialists in engineering and the physical, biological and social sciences who also possess a sound grasp of overall objectives and a full appreciation of the respective roles of the participating disciplines.

Water resources is generally considered to be an area of specialization and not a discipline. Graduate education should provide an opportunity for broad training in water-related subjects along with intense study in the major disciplines. Students with an interest in water resources should be encouraged to reach beyond their own departments for courses to extend their range of understanding and to participate in water resources courses and seminars designed to develop interdisciplinary communication and a basis for future working relationships.

A large number of courses related to water resources conservation, development and management are currently offered on the Raleigh and Chapel Hill campuses of the University. There is a highly qualified faculty representative of the multiplicity of disciplines involved. In order to capitalize on the combined training resources of both campuses and to offer them in an organized way to graduate students seeking interdisciplinary training in this field, the University has approved a new intercampus graduate minor in water resources which is being initiated at the present time.

The new program offers a strong graduate minor in water resources, with the major in any of the basic disciplines contributing to water resources planning, conservation, development and management. The graduate courses currently offered on both campuses have been reviewed and courses dealing with water resources have been separated into the following general areas:

Water law and institutions

Planning of water resources and related systems

Municipal and industrial water management

Agricultural and forest water management

Aquatic biology and ecology

Hydrology and hydrogeology

Graduate students majoring in any discipline closely allied with one of the designated water resource areas will be qualified for admission to the program. They will be expected to select their water resources minor courses from one or more areas outside their major. The cohesive elements in the graduate program will be two interdisciplinary core courses including a water resources seminar and a course in water resources planning. The core courses to be presented on the Raleigh campus are described as follows:

EC 590 SPECIAL ECONOMICS TOPICS (WATER RESOURCES PLANNING) 3(3-0) S

This section of Special Economics Topics offers interdisciplinary study of the complex legal, political, economic, social, biological and engineering aspects of water resources planning for optimum water conservation, utilization and management. Includes an introduction to contemporary planning techniques. Case studies of plans for multipurpose river basin development will be used as a framework for understanding of disciplinary input and interaction.

Graduate Staff

CE 591 CIVIL ENGINEERING SEMINAR (WATER RESOURCES) 1(1-0) F

As offered for the water resources minor, this seminar provides an overview of water resources conservation, planning, development and management. Topics presented by visiting lecturers, graduate faculty and students. Mr. Howells

The complete listing of courses available under this program is presented in a brochure, *Water Resources Graduate Programs*.

The minimal course requirements for a graduate minor in water resources are:

Master's Degree—the two core courses in water resources plus two courses in water resource areas outside the major discipline approved by the student's advisory committee;

Ph.D. Degree—the two core courses in water resources plus five other courses in water resource areas outside the major discipline approved by the student's advisory committee.

Requests for information regarding the water resources graduate programs should be directed to the Chairman of the Water Resources Committee, the departments represented on the Water Resources Committee or the Water Resources Research Institute, 124 Riddick Building, N. C. State University, Raleigh, 27607.

ZOOLOGY

GRADUATE FACULTY

Professor DAVID E. DAVIS, *Head*

Professors: FREDERICK S. BARKALOW, JR., DANIEL S. GROSCH, REINARD HARKEMA, WILLIAM W. HASSLER, DON W. HAYNE, BERNARD S. MARTOF, THOMAS L. QUAY; *Professor Emeritus*: BARTHOLOMEW B. BRANDT; *Adjunct Professors*: MICHAEL POTTER, THEODORE R. RICE, PETER N. WITT; *Associate Professors*: F. EUGENE HESTER, JOHN E. HOBBIIE,

LAWRENCE E. METTLER, GROVER C. MILLER, DONALD E. SMITH, ALASTAIR M. STUART; *Visiting Associate Professor*: THOMAS A. GAUCHER; *Adjunct Associate Professor*: THOMAS W. DUKE; *Assistant Professors*: PHYLLIS C. BRADBURY, DONALD B. HORTON, JOHN F. ROBERTS; *Adjunct Assistant Professors*: JOSEPH W. ANGELOVIC, B. DEAN NELSON, JOHN G. VANDENBERGH, RICHARD B. WILLIAMS, DOUGLAS A. WOLFE

The Department of Zoology offers to qualified students the opportunity to earn the Master of Science and the Doctor of Philosophy degrees. Students may specialize in many areas: behavior, general ecology, population dynamics, limnology, marine biology, fisheries biology, wildlife biology, taxonomy and ecological life histories of parasites, comparative morphology and systematics of vertebrates, cellular and comparative physiology, and endocrinology.

The department is located in Gardner Hall where facilities for a wide variety of research activities are available. Excellent opportunity for many types of ecological studies is provided in the extensive natural areas of state parks; some are only six miles from campus. Several off-campus laboratories are available to students and staff.

By mutual agreement, a student may choose to do research with any member of the graduate staff. A student will make up a plan of study after discussing his interests and objectives with his major professor and advisory committee. Those courses will be selected which best prepare him for his particular interests. Advanced courses in other departments provide a variety of subjects for minor fields of study: botany, entomology, genetics, statistics, biomathematics, biochemistry, psychology and other related sciences. The student is given the opportunity to develop a high order of independent thought, broad knowledge, technical skills and thorough training in investigative techniques. Strong emphasis is placed on active participation in seminars, practice in the methods of original research and preparation of manuscripts for publication in scientific journals.

A variety of positions is open to students holding advanced degrees. There is a great need for professional zoologists in teaching and research in institutions of higher learning and in industry. Research personnel are especially in demand in behavior, physiology and other medically related sciences. Numerous positions with the Fish and Wildlife Service, the Soil Conservation Service, the Forest Service and the Park Service are open to zoologists.

A prospective student must submit Graduate Record Examination scores for the verbal, quantitative and advanced tests with the application for admission.

SPECIAL FACILITIES FOR MARINE RESEARCH

(1) The Hatteras Marine Laboratory is located at the southern end of Hatteras Island, North Carolina, where a variety of interesting biological habitats occur. Cape Hatteras is the closest point to the Gulf Stream north of Daytona Beach, Florida. Both northern and southern faunas are found in adjacent waters.

(2) The Pamlico Marine Laboratory near Aurora, North Carolina, is located on the Pamlico River Estuary not far from Pamlico Sound. The

research here concerns both basic marine ecology and the effects of man's activities on the natural estuarine environment, particularly industrial and domestic pollution.

(3) The Radiobiological Laboratory at Beaufort, North Carolina, is supported by the Bureau of Commercial Fisheries and by the Atomic Energy Commission.

FOR ADVANCED UNDERGRADUATES

ZO 414 (BO 414) CELL BIOLOGY 4(3-3) FS
(See Botany, page 71.)

ZO 420 FISHERY SCIENCE 3(2-3) F
Prerequisites: ZO 201, ZO 442

The science of fishery biology, life history and biology of important game and commercial fishes, fishing methods, age and growth analysis, survey of fishery resources, tagging studies, population estimations and pollution studies.

Messrs. Hassler, Hester

ZO 421 VERTEBRATE PHYSIOLOGY 4(3-3) FS
Prerequisites: Organic chemistry, physics, ZO 201

Physiology of vertebrates with emphasis on mammals. A comprehensive study of the mechanisms which operate to sustain life.

Mr. Smith, Staff

ZO 441 ICHTHYOLOGY 3(2-3) S
Prerequisite: ZO 223

The classification and ecology of selected groups of fishes. Lectures, laboratories and field trips dealing with the systematics, life histories, interrelationships and distribution of the particular groups of fishes.

Mr. Hassler

ZO 442 (BO 442) GENERAL ECOLOGY 4(3-3) F
Prerequisite: BS 100 or equivalent

The general principles of the interrelationships among organisms, and between organisms and their environment—land, fresh-water and marine.

Messrs. Cooper, Standaert

ZO 450 INVERTEBRATE ZOOLOGY 4(3-3) S
Prerequisite: ZO 201

The biology and classification of the invertebrate animals with special reference to types commonly encountered and to those which illustrate zoological principles.

Mrs. Bradbury

FOR GRADUATES AND ADVANCED UNDERGRADUATES

ZO 501 ORNITHOLOGY 3(2-3) F
Prerequisites: ZO 223, ZO 421

The biology of birds—systematics, physiology, life histories, ecology and behavior.

Mr. Quay

ZO 510 ADAPTIVE BEHAVIOR OF ANIMALS 4(3-3) F
Prerequisite: ZO 421 or consent of instructor

The comparative study of animal behavior including a treatment of physiological mechanisms and adaptive significance. Both invertebrates and vertebrates are studied. Mr. Stuart

ZO 513 COMPARATIVE PHYSIOLOGY 4(3-3) F
Prerequisites: ZO 421, ZO 450 or consent of instructor

A comparative study of the organ systems of vertebrates and invertebrates and the physiological processes involved in maintaining the homeostatic state. The various compensatory mechanisms employed during environmental stress are included. Graduate Staff

ZO 515 GROWTH AND REPRODUCTION OF FISHES 3(2-3) S
Prerequisites or Corequisites: GN 411, ZO 420, ZO 421, ZO 441

The biology of fishes: physiology, anatomy, pathology, behavior and genetics. This course is designed especially for graduate students in fisheries. Several trips to research laboratories are taken. Mr. Hester

ZO 517 POPULATION ECOLOGY 3(3-0) S
Prerequisites: ZO 442, ST 511 or equivalent

The dynamics of natural populations. Current work, theories and problems dealing with problems of making measurements on natural populations and with population growth, fluctuations, limitation and patterns of dispersion, the ecological niche, food chains and energy flow. Mr. Hayne

ZO 519 LIMNOLOGY 4(3-3) F
Prerequisite: ZO 442 or equivalent

A study of inland waters. Lectures dealing with physical, chemical and biological factors that affect freshwater organisms. General principles are illustrated in the laboratory and in the field. Mr. Hobbie

ZO 524 (PO 524) COMPARATIVE ENDOCRINOLOGY 4(3-3) S
(See Poultry Science, page 229.)

ZO 529 (OC 529) BIOLOGICAL OCEANOGRAPHY 3(3-0)
Prerequisite: ZO 442 or consent of instructor

A comprehensive course stressing the dynamic interrelationships between organisms of the sea and their physical and chemical environment. The latter part of the course will examine fundamental concepts in biological oceanography and will particularly stress experimental methods. Mr. Horton

ZO 532 (GN 532) BIOLOGICAL EFFECTS OF RADIATIONS 3(3-0) S
(See Genetics, page 151.)

ZO 540 (GN 540) EVOLUTION 3(3-0) F
(See Genetics, page 151.)

ZO 542 HERPETOLOGY 3(2-3) S
Prerequisites: ZO 223, ZO 421

The biology of the amphibians and reptiles: systematics, life history, anatomy, behavior, physiology and ecology. Mr. Martof

ZO 544 MAMMALOGY 3 (2-3) S

Prerequisites: ZO 223, consent of instructor

The classification, identification and ecology of the major groups of mammals.
Messrs. Barkalow, Davis

ZO 550 (GN 550) EXPERIMENTAL EVOLUTION 3 (3-0) S

(See Genetics, page 151.)

ZO 553 PRINCIPLES OF WILDLIFE SCIENCE 5 (3-4) F

Prerequisites: ZO 201, ZO 442

The principles of wildlife management and their application are studied in the laboratory and in the field.
Mr. Barkalow

ZO 555 (MB 555) PROTOZOOLOGY 4 (2-6) F

Prerequisite: ZO 450 or equivalent

The biology of the protozoa: morphology, physiology, ecology, genetics, reproduction, evolution, systematics and life-cycles of both free-living and parasitic taxa. Laboratory study will stress recognition of selected forms and demonstrate techniques used to prepare specimens for microscopic examinations.

Mrs. Bradbury

ZO 581 HELMINTHOLOGY 4 (2-4) F

Prerequisites: ZO 223, ZO 315 or equivalent

The study of the morphology, biology and control of the parasitic helminths.
Messrs. Harkema, Miller

ZO 582 (ENT 582) MEDICAL AND VETERINARY ENTOMOLOGY 3 (2-3) S

(See Entomology, page 125.)

ZO 590 SPECIAL STUDIES Credits Arranged

Prerequisites: Twelve hours in zoology, consent of instructor

The investigation of a particular problem in zoology. A maximum of three semester hours is allowed toward a degree.
Graduate Staff

ZO 592 TOPICAL PROBLEMS 1-3

Prerequisite: Consent of instructor

Organized, formal lectures and discussions of a special topic.

Graduate Staff

FOR GRADUATES ONLY**ZO 603 ADVANCED PARASITOLOGY 3 (2-3) S**

Prerequisite: ZO 581

The study of the theoretical and practical aspects of parasitism; taxonomy, physiology and immunology of animal parasites.

Messrs. Harkema, Miller, Roberts

ZO 610 CURRENT ASPECTS OF ANIMAL BEHAVIOR 4 (3-3) F

Prerequisite: ZO 510 or equivalent

Lectures, discussions, seminars and laboratories. The course will treat in detail selected aspects of the behavior of invertebrates and vertebrates. The relationship of behavior to physiology, ecology and other related biological fields will be emphasized.

Mr. Stuart

ZO 614 ADVANCED CELL BIOLOGY**3(3-0) S**

Prerequisites: CH 551, ZO 414, consent of instructor

A study of the current problems of cell biology including the problems of the molecular organization and functions of membrane systems, subcellular organelles and specialized cells.

Messrs. Roberts, Smith

ZO 615 ADVANCED CELL BIOLOGY LAB**1(0-3) S**

Prerequisite: BCH 652

Corequisite: ZO 614

The theoretical basis and utilization of techniques of cell physiology with emphasis on the principles involved, practical limitations and applications in current research.

Messrs. Roberts, Smith

ZO 619 ADVANCED LIMNOLOGY**3(1-6) S**

Prerequisite: ZO 519

A study of primary productivity, population interactions and effects of pollution. An experimental approach is used in the laboratory.

Mr. Hobbie

ZO 621 FISHERY SCIENCE**3(2-3) F**

Prerequisites: ST 511, ZO 420, a course in calculus

An analysis of fishery research methods. Population enumeration and dynamics. The relationship between fluctuations in natural populations and environmental factors. (Offered 1967-68 and alternate years.)

Mr. Hassler

ZO 690 SEMINAR**1(1-0) FS**

The presentation and defense of original research and current literature. It is assumed that graduate students will attend the departmental seminar.

Graduate Staff

ZO 699 RESEARCH IN ZOOLOGY**Credits Arranged**

Prerequisites: Twelve hours in zoology, consent of instructor

Original research related to a student's thesis. A maximum of six hours is allowed toward the master's degree; any number toward the doctorate.

Graduate Staff

GRADUATE FACULTY*

NORTH CAROLINA STATE UNIVERSITY at Raleigh

- J. B. ADAIR, *Professor of Adult Education.*
Ph.D., University of Texas.
- DEWEY ALLEN ADAMS, *Associate Professor of Adult Education.*
Ed.D., University of Florida.
- WILLIAM L. ALSMEYER, *Assistant Professor of Animal Science.*
Ph.D., University of Illinois.
- RAUL EDUARDO ALVAREZ, *Associate Professor of Industrial Engineering.*
M.S., North Carolina State University.
- MICHAEL AMEIN, *Associate Professor of Civil Engineering.*
Ph.D., Cornell University.
- CHARLES EUGENE ANDERSON, *Assistant Professor of Botany.*
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- CLIFTON A. ANDERSON, *Professor of Industrial Engineering and Head of Department.*
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- DONALD BENTON ANDERSON, *Professor of Botany.*
Ph.D., Ohio State University.
- NORMAN DEAN ANDERSON, *Associate Professor of Mathematics and Science Education.*
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- ROY NELS ANDERSON, *Professor of Education.*
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- JOSEPH WILLIAM ANGELOVIC, *Adjunct Assistant Professor of Zoology.*
Ph.D., Utah State University.
- JAY LAWRENCE APPLE, *Professor of Plant Pathology, Director of the Institute of Biological Sciences and Assistant Director of Research, School of Agriculture and Life Sciences.*
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- FRANK BRADLEY ARMSTRONG, *Associate Professor of Genetics, Microbiology and Biochemistry.*
Ph.D., University of California.
- CLARENCE MONROE ASBILL, JR., *Professor of Textiles and Head of Department of Textile Machine Design and Development.*
B.S., Clemson College.
- LEONARD WILLIAM AURAND, *Professor of Food Science and Biochemistry.*
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- LEONARD GEORGE AUSTIN, *Professor of Chemical Engineering.*
Ph.D., Pennsylvania State University.
- WILLIAM WYATT AUSTIN, JR., *Professor of Metallurgical Engineering and Head of Department of Mineral Industries.*
Ph.D., Vanderbilt University.

* Membership in the graduate faculty may be in either of two categories: (1) full status or (2) associate status. Full status permits a faculty member to engage in any and all phases of the graduate programs of the University. Associate members may teach courses at the graduate level and serve as chairmen of master's advisory committees.

- RICHARD CHARLES AXTELL, *Associate Professor of Entomology.*
Ph.D., Cornell University.
- ROBERT AYCOCK, *Professor of Plant Pathology.*
Ph.D., North Carolina State University.
- WALTER PETER BAERMANN, *Professor of Product Design.*
Ph.D., University of Munich, Germany.
- JOHN ALBERT BAILEY, *Associate Professor of Mechanical and Aerospace Engineering.*
Ph.D., University College of Swansea.
- JACK VERNON BAIRD, *Extension Professor of Soil Science.*
Ph.D., Washington State University.
- DAVID STAFFORD BALL, *Assistant Professor of Economics.*
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- ERNEST A. BALL, *Professor of Botany.*
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- CLIFFORD WARREN BARBER, *Professor Emeritus of Poultry Science.*
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M.S., Cornell University.
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- *DANIEL FROMM, *Professor of Food Science.*
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2. ALUMNI
3. PRIMROSE

5. PEELE
6. WATAUGA
7. BROOKS
8. FOURTH
9. GOLD
10. WELCH
11. BAGWELL
12. BERRY
13. BECTON
14. CLARK
15. FRANK THOMPSON GYM
16. SYME
17. FIELD HOUSE
19. KING
20. LEAZAR
21. LEE
22. TOMPKINS
23. WINSTON
24. CERAMICS

25. PAGE
26. PARK SHOPS
27. MORRIS
28. LAUNDRY
29. POWER PLANT
30. RIDDICK
31. DANIELS
32. MANN
33. WITHERS
34. 1911 BUILDING
35. RICKS
36. PATTERSON
37. BURLINGTON NUCLEAR LABS
38. WILLIAM NEAL REYNOLDS COLISEUM
39. CARMICHAEL GYMNASIUM
41. ALEXANDER
42. STUDENT SUPPLY STORE
43. BUREAU OF MINES
44. BROUGHTON
45. POLK
46. HARRELSON
47. D. H. HILL LIBRARY

48. ERDAHL-CLOYD UNION
49. SCOTT
50. GARDNER
51. WILLIAMS
52. AGRONOMY GREENHOUSES
53. LABORATORY BUILDING
54. OWEN
55. TURLINGTON
56. TUCKER
57. CAFETERIA
58. KILGORE
59. NELSON
60. MANGUM
61. PRINT SHOP
62. BRAGAW
63. BRANDON P. HODGES
64. ROBERTSON
65. AGRICULTURAL ENGINEERING
66. ANIMAL DIAG LABORATORY
67. WUNC-TV
68. MARRIED STUDENT HOUSING
69. PRATERNITY HOUSING



NORTH CAROLINA STATE RECORD



SUMMER
SESSIONS
1968

North Carolina State University • Raleigh

COVER

One of State's newest landmarks is the brick mall at the center of the campus. Surrounded by numerous University buildings including the D. H. Hill Library, Harrelson Hall and the Erdahl-Cloyd Union, the mall is a pleasant place to relax or study. (Photo courtesy the Technician.)

NORTH CAROLINA STATE RECORD

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FEBRUARY 1968

NUMBER 1



**SUMMER
SESSIONS**

1968

North Carolina State University · Raleigh

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ADMINISTRATION

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William S. Wells, *Vice-president for Academic Affairs*

Arnold K. King, *Vice-president for Institutional Studies*

Frederick H. Weaver, *Vice-president for University Relations*

Alexander H. Shepard, Jr., *Assistant Vice-president for Finance and Treasurer*

Rudolph Pate, *Assistant to the President*

NORTH CAROLINA STATE UNIVERSITY

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J. Bryant Kirkland, *Dean, School of Education*

Ralph E. Fadum, *Dean, School of Engineering*

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David D. Chaney, *Dean, School of Textiles*

SUMMER SESSIONS

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Charles F. Kolb, *Associate Director*

ADMISSIONS

Kenneth D. Raab, *Director*

REGISTRATION

Ronald C. Butler, *Registrar*

SUMMER SESSIONS CALENDAR 1968

FIRST SESSION

May 24	Friday	Last day to preregister.
June 4	Tuesday	New student orientation; registration and payment of fees; late registration fee for those who register after 1:00 p.m., June 4.
June 5	Wednesday	First day of classes.
June 10	Monday	Last day to register; last day to withdraw (or drop a course) with refund; last day to drop a course without a grade.
July 11	Thursday	Last day of classes.
July 12	Friday	Final examinations.

SECOND SESSION

July 4	Thursday	Last day to preregister.
July 16	Tuesday	New student orientation; registration and payment of fees; late registration fee for those who register after 12:00 noon, July 16.
July 17	Wednesday	First day of classes.
July 18	Monday	Last day to register; last day to withdraw (or drop a course) with refund; last day to drop a course without a grade.
August 21	Wednesday	Last day of classes.
August 22	Thursday	Final examinations.



The traditional symbol of North Carolina State University is the 122 foot Memorial Tower.

NORTH CAROLINA STATE UNIVERSITY

North Carolina State University is the center for scientific and technological education, research and service in North Carolina. Created in 1887 by act of the North Carolina legislature as the state's land-grant institution, State was established primarily as a school of agriculture and mechanic arts. In the 77 years since its founding, however, its interests and responsibilities have been greatly broadened in response to the major scientific and technological demands of our rapidly changing world. While maintaining deep commitments to the agricultural and industrial interests of North Carolina, State has developed training and research programs of regional as well as national influence.

North Carolina State University is one of four institutions comprising the Consolidated University of North Carolina, and as such, fulfills particular responsibilities for specialization in graduate and undergraduate training in technical and scientific areas. Undergraduate and graduate degrees may be earned in liberal arts and education as well as agriculture, the sciences, engineering, architecture and design, forest resources and textiles.

State's organization includes eight undergraduate schools, the Graduate School and the Division of Continuing Education. The research, extension and instructional programs of these schools are supported and strengthened by several specialized divisions and offices including the Institutes of Statistics, Water Resources, Agricultural Policy and Biological Sciences; the Computing Center; the Agricultural and Industrial Extension Services; and the Agricultural Experiment Station with its 17 branch stations. State's facilities also include a minerals laboratory and a fisheries research station.

The University faculty and staff numbers more than 1,500 members, including a graduate faculty of 473. Undergraduate enrollment at State is currently 10,600 and there are about 2,000 students enrolled in the Graduate School.

North Carolina State is accredited by the Southern Association of Colleges and Schools and the North Carolina Association of Colleges and Universities. In addition, individual schools and departments are accredited by various associations in their respective fields.

THE SUMMER SESSIONS

The Summer Sessions at North Carolina State University offer an extensive educational program planned to meet the varied needs and interests of 7,000 students. Fifty departments offer instruction in some 400 courses, over one-third of which are at the graduate level.

Each of State's eight schools, with a combined faculty of more than 300, participates in the program for summer study: six schools offer courses during the two regular six-week sessions, the School of Design offers one nine-week program, the School of Forest Resources conducts a summer camp for sophomores and two five-week practicums, and the School of Agriculture and Life Sciences offers a three-week program for extension workers. In addition, many special programs and institutes are offered during the summer by the University.

Summer courses and special programs are designed for the **new student**, the **undergraduate** wanting to advance his academic standing at State, the **graduate** desiring to continue his study and research during the summer months, and for **visiting students** pursuing degrees at other institutions. Teachers who need to earn credit toward renewal of teaching certificates or advanced degrees in education, and persons in professional fields who wish to keep abreast of new developments and trends also take advantage of State's summer programs. In addition, the Summer Sessions offer the opportunity of taking required subcollege level work in English and mathematics to high school students planning to enroll at State.

ADMISSIONS

Students are admitted to the Summer Sessions in one of four categories: (1) new freshmen; (2) new undergraduate transfer students; (3) new graduate students; and (4) special students.

NEW FRESHMEN

Application forms for new freshmen should be obtained from the **Director of Admissions, Peele Hall**.

Students entering North Carolina State University are normally expected to be high school graduates. For the best preparation it is suggested that the applicant have completed four units in English, four units in mathematics (including advanced algebra and trigonometry), two units in science (including either chemistry or physics), two units in social science (including United States history), and, if the student plans to enter the School of Liberal Arts, two units in a modern foreign language.

Freshman applicants must take the Scholastic Aptitude Test of the College Entrance Examination Board and have their scores submitted to the Office of Admissions by the Board. These scores, together with the high school record, will be considered in determining admissibility. Information as to the time and place the Scholastic Aptitude Test will be given may be obtained from high school principals or counselors, or by writing directly to the College Entrance Examination Board, Box 592, Princeton, New Jersey, for the *Bulletin of Information*; it includes an application form and is available without charge. Candidates interested in advanced or special placement in English, mathematics or chemistry should take the College Board Achievement Tests in these subjects, preferably at the March or May administration of their senior year in high school. Also, the Mathematics Achievement Test, Level I will be useful in helping to identify those students in engineering, physical sciences, mathematics and certain other curricula who are ready to enroll in MA 102, Analytic Geometry and Calculus I.

NEW TRANSFER STUDENTS

In addition to submitting an application form which may be obtained from the Director of Admissions, Peele Hall, all transfer students must have official transcripts sent to the Office of Admissions directly from all other colleges attended.

All applicants for transfer must have at least an overall "C" average on prior college work and must be eligible to return to the last institution attended.

Transfer students with less than 28 semester hours of transfer credit must also follow the procedures for entering freshmen as outlined above.

NEW GRADUATE STUDENTS

All students working toward advanced degrees are enrolled in the Graduate School. An application for Graduate School admission may be obtained from the Dean of the Graduate School, Peele Hall.

STUDENTS ADMITTED TO THE FALL SEMESTER

Any student cleared for regular admission for the fall semester wishing to attend either summer session should notify the Admissions Office, Peele Hall, to change his date of entrance. He should not fill out a summer sessions application.

SPECIAL STUDENTS

Special students must complete the Summer Sessions Registration Application located in the front of this catalog. A special student is one who has not been formally admitted as a degree candidate at North Carolina State University and does not wish a regular classification of any kind at the University. All students visiting from other schools will be classified as special students. Special students are limited to a class

load of not more than seven semester hours. In unusual cases, a special student visiting from another college may be allowed to take more than seven hours if permission is obtained from the Director of Summer Sessions.

NOTE: Public school teachers who have never been enrolled as regular students at North Carolina State University and who are renewing an "A" certificate may register as special students if they desire; those renewing a graduate certificate should register as a Graduate Certificate Renewal or as a Graduate Special. The Division of Professional Services requires a graduate classification for the renewal of a graduate certificate. Students desiring regular graduate status must apply for admission through the Graduate Office.

READMISSION

Former North Carolina State University students who wish to attend the Summer Sessions must apply for readmission through the Department of Registration and Records at least 30 days prior to the intended date of return. The readmissions application may be obtained by writing to the Office of Registration and Records, Peele Hall, North Carolina State University, Raleigh, North Carolina 27607.

REGISTRATION

PREREGISTRATION

All students who plan to attend Summer School must preregister. Preregistration consists of selecting the courses to be taken during the first and/or second sessions, and filing the preregistration course request(s) with the Summer Sessions Office, Room 134, 1911 Building. The courses selected by each student are processed through the computer which assigns a day and hour for each course request. On registration day each student obtains his completed class schedule.

Currently enrolled students will preregister for the first and/or second session with their advisors at the time they preregister for the 1968 fall semester, April 26 through May 10.

Former students returning will preregister for the first and/or second session with their advisors during the period, April 26 through May 10, if possible. The last day to preregister for all students for the first session is May 24.

New freshmen who desire to attend summer school should contact the Admissions Office prior to May 24.

Special students will preregister through the Summer Sessions Office by mail or in person anytime through May 24; however, special students are encouraged to preregister as early as possible.

NOTE: The last day to preregister for all students for the first session is May 24. Students preregistering between April 26 and May 10 stand an excellent chance of enrolling in the courses of their choice.

A special preregistration period for the second session will be held Monday, June 17 through Wednesday, June 19, for those students (special or regular) who have not preregistered previously. The last day to preregister for the second session is July 4.

REGISTRATION

All students will complete registration on June 4 (first session) and/or July 16 (second session) at the Reynolds Coliseum. Completing registration consists of three steps: (a) completing registration cards, (b) obtaining previously prepared class schedule, (c) paying tuition and fees.

Registration for the first session for all students will be held at Reynolds Coliseum on Tuesday, June 4, from 8:30 a.m. to 1:00 p.m.

Registration for the second session for all students will be held at Reynolds Coliseum on Tuesday, July 16, from 8:30 a.m. to 12:00 noon.

NOTE: Students who fail to preregister will not be allowed to complete registration on registration day, thus causing a delay in attending classes.

LATE REGISTRATION

A late registrant is one who (a) fails to preregister and/or (b) fails to complete registration cards and obtain class schedule on June 4 or July 16. Late registrants will be charged a \$10 late registration fee. Late registrants will be delayed in starting classes.

SPECIAL NOTES

1. Tuition and fees are payable by check or cash on the day of registration. Students should have the necessary funds with them.

2. Students planning to take courses in both sessions should plan their sequences well in advanced. Offerings in the second session are often substantially less in number than in the first session, and, in many instances, departments do not offer courses in both sessions during the summer.

3. Everything possible will be done to ensure that the courses listed in this catalog will be given at the times indicated. The Director of the Summer Sessions reserves the right, however, to withdraw courses in which the enrollment is deemed insufficient.

4. The normal load for either session of Summer School is six or seven semester hours. Any student may carry less. Regularly enrolled students who desire to carry more than seven hours must obtain the approval of the Dean or Director of Instruction of the school in which they are enrolled. Such approval must be in writing and presented to the Director of Summer Sessions. Students visiting from other schools who wish to take more than seven hours must obtain the approval of the Director of Summer Sessions.

EXPENSES

The following expenses apply for each of the regular six weeks sessions.

TUITION AND FEES

RESIDENT Required				NONRESIDENT Required			
Hours	Tuition	Fees	Total	Hours	Tuition	Fees	Total
1	\$ 7.50	\$23.50	\$31.00	1	\$ 21.00	\$23.50	\$ 44.50
2	15.00	23.50	38.50	2	42.00	23.50	65.50
3	22.50	23.50	46.00	3	63.00	23.50	86.50
4	30.00	23.50	53.50	4	84.00	23.50	107.50
5	37.50	23.50	61.00	5	105.00	23.50	128.50
6	45.00	23.50	68.50	6	126.00	23.50	149.50
7	52.50	23.50	76.00	7	147.00	23.50	170.50
8	60.00	23.50	83.50	8	168.00	23.50	191.50
9	67.50	23.50	91.00	9	189.00	23.50	212.50
10	75.00	23.50	98.50	10	210.00	23.50	233.50

REQUIRED FEES

Registration	\$ 7.00
Medical	2.50
Student Center	10.00
Physical Education	4.00
	<hr/>
	\$23.50

SPECIAL REGISTRATIONS AND FEES

Degree Only	\$10.00
Thesis Preparation Only—	
In-residence (\$15.00 plus \$23.50 fees)	\$38.50
Not-in-residence (\$15.00 plus \$7.00 registration fee)	\$22.00
Examination Only—	
In-residence (\$8.00 plus \$23.50 fees)	\$31.50
Not-in-residence (\$8.00 plus \$7.00 registration fee)	\$15.00
Audits (\$7.50 per hour—no fees)	
Full-time Faculty and Staff	\$ 7.00

SPECIAL NOTICES

Certain nonacademic fees may be waived for students who are both full-time professionally employed and enrolled for only one course. Applications for cancellation of nonacademic fees may be obtained from the Office of Business Affairs, P. O. Box 5067. Any student enrolled for more than one course per session must pay full fees.

A late fee of \$10.00 will be charged all students completing their registration after the designated time.

GRADUATION FEE

Any student completing requirements for graduation at the close of one of the Summer Sessions will be charged a fee of \$9.00 if he is securing a bachelor's degree, a fee of \$12.00 if he is a candidate for the master's degree, and a fee of \$17.00 if he is completing work for the Doctor of Philosophy degree. The Graduate School will also charge Doctor of Philosophy candidates a fee of \$21.00 for microfilming and mailing dissertations.

REFUNDS

A student who withdraws from school on or before the last day of registration will receive a refund of the full amount paid for tuition and fees, less a \$7.00 registration fee. On later withdrawals no refund is made.

FINANCIAL AID

The financial aid available to summer school students is ordinarily limited to loans and jobs. For summer visitor students part-time employment is the only aid that can be offered.

LONG-TERM, LOW-INTEREST LOANS

Entering freshmen admitted to North Carolina State University for 1968-69 or continuing enrolled students in good academic standing at North Carolina State University may borrow under the National Defense Student Loan Plan or from institutional loan funds. Repayment and interest at three percent begin nine months after a student ends his studies.

SHORT-TERM EMERGENCY LOANS

Small short-term loans are available for qualified, regularly enrolled students to meet unexpected expenses. These loans must be repaid in 30 to 60 days, and are not extended beyond the end of a term.

EMPLOYMENT

WORK-STUDY JOBS

Entering freshmen at North Carolina State University and continuing students at North Carolina State University who can demonstrate need may be eligible for work under the federally sponsored College Work-study Program. Students are limited to 15 hours of work per week while attending classes. Students may work on or off campus 40 hours per week during the vacation periods.

OTHER PART-TIME JOBS

Current on- and off-campus job notices received by the Financial Aid Office are posted at 205 Peele Hall. These jobs are available both to regular students and to summer visiting students. Because of less demanding schedules the competition for available jobs is keener in the summer.



Holladay Hall, originally the entire college plant, now houses the main administrative offices.

HOUSING

In order that students may live in an atmosphere conducive to the pursuit of academic excellence and personal development, North Carolina State University strives to provide comfortable and attractive housing accommodations. Bragaw and Lee Halls will be available for men and Alexander Hall for women during the first regular summer session and as needed the second session.

Residence halls are staffed by competent counselors appointed to assist residents in their personal adjustment to group living situations, to develop and maintain suitable conditions for study and rest, and to encourage high academic pursuits. These counselors are also responsible for the implementation of University policies and regulations which have been established to insure the best interest and welfare of each individual in the total living group. Residence hall policies are posted in each room and compliance is expected of all residents.

Students are assigned to the residence hall area of their choice, insofar as possible, regardless of their classification or curriculum. Bragaw and Lee are modern residence halls providing accommodations for men in suites. Each suite has four two-man rooms and a bath. Alexander Hall is a traditional style residence hall with double rooms on either side of an interior corridor with common bath and shower facilities for each floor. Residence hall rooms are equipped with the necessary articles of furniture; however, personal items such as clocks, radios, etc., are not supplied. Linen, pillows and blankets are not provided but are available through the linen rental service of the University laundry at reasonable rates.

Mail is delivered directly to the residence halls by the U. S. Postal Service daily except Sunday. Regular six weeks session students should have their mail addressed as follows:

"Name of Student"
Post Office Box Number _____
North Carolina State University
Raleigh, N. C. 27607

Participants in short courses, conferences and workshops that are less than one month should have their mail addressed to them in care of the director of their program.

Residence hall rental rates for each six weeks summer session are \$48.00 for men and \$54.00 for women. The linen rental fee is \$5.00 per session.

A University Residence Hall Reservation Card will be mailed to each student cleared for admission to a regular summer session. The instructions printed on the card should be followed to secure a residence hall reservation. Rental fees should be mailed in the preaddressed envelope to the Office of Business Affairs. Key deposits are not required; however, a \$10.00 charge (\$5.00 late fee and \$5.00 key replacement fee) will be assessed if the keys are not returned by the date announced by the Housing Rental Office.

Limited space is available for married students in University owned apartments. Inquiries should be addressed to the Housing Rental Office, Leazar Hall, North Carolina State University.

Participants in short courses, conferences and workshops should contact the director of their program for additional housing information.

HOUSING RENTAL FEES

Men's Residence Hall (two per room)	\$48.00
Women's Residence Hall (two per room)	\$54.00

RESIDENCE HALL REFUND POLICY

If a reservation is cancelled at the Housing Rental Office, Leazar Hall, in person or in writing at least seven days prior to the first day of classes (date of cancellation is date notification is received at that office), the rent paid will be refunded, less a \$12.50 reservation fee. After this date, no refund will be made for any reason other than failure to register or official withdrawal from the University. If a reservation is cancelled for either of these reasons, the rent paid will be refunded, less a \$12.50 reservation fee or a daily charge of \$2.00 for men and \$2.25 for women for the seventh day preceding the first day of classes to the date of cancellation, whichever amount is greater. If a student fails to check in and secure his keys on or before the first day of classes, his reservation will be subject to cancellation and no refund will be made except as stated above.

LINEN RENTAL SERVICE

Linen rental service may be obtained by writing to the Director of Auxiliary Services, Room 9, Holladay Hall, and enclosing \$5.00 for each session of summer school. Pillows are available for \$.75 per session and plain blankets may be obtained at a cost of \$2.00 per session. These services may be obtained after arrival upon campus in the residence halls or at Room 9, Holladay Hall.

Laundry and dry cleaning service is available on campus at nominal rates.

FOOD SERVICE

Food service will be provided in cafeterias adjacent to the residence halls. This seven-day service is offered at reasonable rates.

D. H. HILL LIBRARY

The D. H. Hill Library of North Carolina State University houses a collection of more than 400,000 volumes of books and bound journals. The collection has been developed to reflect the scientific and technological interests of the University, but the arts and social sciences are also

well represented. The Library subscribes to more than 5,600 current periodicals and receives all publications of the various experiment stations. The Library has been a depository for U.S. government publications since 1924 and has been designated as one of the depositories for all unclassified publications of the Atomic Energy Commission, National Aeronautics and Space Agency, as well as the Food and Agricultural Organization of the United Nations. Publications from many foreign countries are received on exchange—especially those publications dealing with the sciences and engineering.

Two special interest collections form on-campus branches of the main library. The Textiles Library contains outstanding holdings in textiles and textile chemistry. The School of Design Library has an excellent collection of books, journals and slides in the fields of architecture, landscape architecture and product design.

There are several reading rooms in the air-conditioned library building, and carrels, conference and seminar rooms are available for students and faculty. The Library maintains a photocopy service and equipment for reading microfilms and microcards is available.

The scholar, student and browser will each discover the materials and services of the Library to be useful and enjoyable additions to his Summer Sessions program.

Library hours for Summer Sessions are as follows:

Mon.-Fri.	8:00 a.m.-11:00 p.m.
Saturday	8:00 a.m.-5:00 p.m.
Sunday	2:00 p.m.-6:00 p.m.

SUMMER ACTIVITIES

Through many curricular and extracurricular activities, the Summer Sessions provide special opportunities to those students engaged in summer study. Interesting, informative and entertaining programs and activities are scheduled for each session.

A few of the more popular activities and special features include the Carmichael Gym athletic and recreational programs and the varied activities sponsored by the Erdahl-Cloyd Union.

The University's regular program of student personnel services is available to summer students. It includes the Counseling service for educational, career and personal counseling; the Placement service for part-time jobs and career placement; the Housing office for residence quarters; the Student Aid office for financial assistance; and the Student Health office for medical care.

Several of State's buildings are air-conditioned for summer comfort. Among these are the Student Supply Store, where students will find books and equipment for recreational as well as academic pursuits; Harrelson Hall, State's unusual round classroom building where more than half the Summer Sessions classes are held; the Erdahl-Cloyd student union; and Harris dining hall, conveniently located near many of the residence halls.

Beyond the campus, the City of Raleigh offers many cultural and recreational opportunities of interest to students. The Raleigh Little Theatre presents several outdoor productions during the summer; the North Carolina Museum of Art sponsors gallery concerts and exhibits; and there are several swimming pools and city and state parks located in and around Raleigh.

ERDAHL-CLOYD UNION

The center of campus summer activity is the Erdahl-Cloyd Union. The Union programs are financed in part by student fees, and all regularly enrolled students, as members of the Union, are invited to attend, without further charge, the programs and activities sponsored by the Summer Sessions committee. Every member is welcome to join the committee and take part in planning the Union program.

During the summer, the Union sponsors a variety of entertainment. Activities include parties, dances, movies and a varied program of professional entertainment.

The completely air-conditioned Union offers many facilities and services to members and their guests, including a music-listening lounge, a television lounge, a gallery for the display of art and crafts, a library lounge, offices for student organizations and a billiard room. Services include a barber shop, cloak room, snack bar, dining room, hotel rooms and meeting rooms.

Building hours during the summer are:

Mon.-Sat.	7:00 a.m.-11:00 p.m.
Sunday	12:00 noon-11:00 p.m.

SPECIAL COURSES AND INSTITUTES

SPECIAL COURSE FOR ENTERING FRESHMEN

Students beginning their college study in the First Summer Session are encouraged to enroll in *Career Development and Effective Study Techniques*. Tests of vocational aptitude and interest, together with occupational information, will be used to help the student assess the possibilities of various careers. How to study effectively and other topics related to adjustment to college life and study will be the second concern of the course. Individual counseling will supplement class activity. The course will not count as college credit but will be roughly equivalent to a two-hour course in class time.

Students who enroll in this course should, if possible, participate also in the *Summer Reading Workshop*.

The class will meet each weekday at 1:40 until 2:40 p.m. Additional sections will be added if there is sufficient demand. Fee for the course is \$3.00. Students should register at the Counseling Center Office, 210 Peele Hall on or before the day of the first class meeting, Wednesday, June 5.

SUMMER READING WORKSHOP

The annual Summer Reading Workshop sponsored by the School of Education will provide a reading improvement section for entering college students during the first session. Scores on college entrance tests indicate that a number of incoming freshmen could benefit from training in the improvement of reading rate, comprehension and vocabulary building.

Entering college students who are interested in registering for this training should contact Dr. Paul Rust (Tompkins 212), Director of Reading Workshop. The workshop will meet from 11:00 to 12:00 on Monday, Wednesday and Friday mornings in Tompkins 212.

DEPARTMENT OF ADULT EDUCATION

Special Summer Program in Adult Education

June 24-July 12

The Department of Adult Education is offering a special summer program of instruction at the graduate level for extension workers, community college staff members and other adult educators. The program is designed to provide adult educators with the opportunity to bolster their understanding of the adult and society, the theories of learning, social action, group processes, and planning requisite to effecting change among people.

The program is an interdisciplinary approach which utilizes the professional competence of a permanent and associate faculty. The program content encompasses theories and concepts which have applicability to all adult education organizations. Courses taught are in three major categories: (1) Adult Education, (2) Behavioral and Social Sciences, and (3) Natural Sciences.

Fifteen three-credit courses will be offered. Each participant will take only one course. Persons desiring graduate credit must register as a "graduate special" or make application for admission to the Graduate School.

Detailed information concerning course offerings, graduate credit, registration and housing may be obtained by writing to Dr. Robert J. Dolan, State Leader of Training, 113 Ricks Hall, North Carolina State University at Raleigh.

The following courses will be offered:

- ANS 407 Advanced Livestock Production
- CS 511 Tobacco Technology
- EC 523 Planning Farm and Area Adjustments
- EC 533 Agricultural Policy (API)
- ED 503 Programming Process in Adult Education
- ED 554 Planning Programs in Agricultural Education
- ED 559 Principles of Adult Education
- ED 596 Topical Problems in Adult Education (School Law)
- ED 600 Theory of Organization and Administration in Adult Education I (Emphasis on Organization)
- ED 601 Theory of Organization and Administration in Adult Education I (Emphasis on Administration)
- HEC 606 Social and Economic Problems of the Family with Emphasis on Home Management
- HS 432 Vegetable Production
- PP 504 Plant Diseases and Their Control
- SOC 501 Leadership
- SOC 513 Community Organization

INSTITUTE IN BIOLOGY FOR HIGH SCHOOL TEACHERS

June 17-July 26

The Department of Mathematics and Science Education and the Institute of Biological Sciences are offering a program of advanced instruction for high school teachers of biology. The summer institute is supported by the National Science Foundation and is intended to prepare the participants for the teaching of modern biology in the high schools.

The major part of the program will consist of two courses developed for the institute: Foundations of Modern Biology and Cell Biology. These two courses will place emphasis on major biological concepts, an understanding of which will be necessary for the development and teaching of a modern high school biology course. Another important feature of the institute will be the *Evening Lecture Series*. Each week an outstanding scientist will present an evening lecture on a current topic in basic and applied biology. Laboratory work and field trips will supplement the formal class sessions and special lectures.

Stipends, travel and dependency allowances will be provided from the National Science Foundation grant. Application forms are obtainable from the Director, Summer Institute in Biology, 104 Tompkins Hall, North Carolina State University, Raleigh, North Carolina. Forty participants are to be selected to receive stipend awards.

INSTITUTE IN EARTH SCIENCE FOR SECONDARY SCHOOL TEACHERS

June 17-July 26

A summer Institute in Earth Science for secondary-school science teachers will be conducted by the Departments of Mathematics and Science Education and Geosciences and supported by the National Science Foundation. Participants will be enrolled in three courses—Physical-Historical Geology, Weather and Climate, and Seminar in the Teaching of Earth Science. Formal class sessions, laboratory work and field trips will be supplemented by special lectures and other programs.

Stipends, travel and dependency allowances will be provided from the National Science Foundation grant. Application forms are obtainable from the Director, Summer Institute in Earth Science, 104 Tompkins Hall, North Carolina State University, Raleigh, North Carolina. Forty participants are to be selected to receive the stipend awards.

SUMMER INSTITUTE FOR FOREIGN STUDENTS

July 1-August 2

The Institute for Foreign Students at North Carolina State University is designed for those students from other countries who intend to pursue university studies or specialized training programs in the United States during the academic year beginning in September. It is designed to furnish them with intensive instruction and practice in the use of the English language. Emphasis will be placed on developing fluency in speaking and understanding English in addition to developing the regular reading and writing skills. Also, the institute will offer an orientation to American life and institutions in order to give the students an insight into the political and social conditions of the area and the nation. There will be field trips to various industries and places of historic, cultural and scenic interest on weekends.

Any student who has a score of 300 or above on the Test of English as a Foreign Language (TOEFL Test) or an equivalent facility in the use of spoken English is eligible to attend the institute. (Information about taking the TOEFL Test at one of the centers located in the students' home countries may be obtained by writing to: Test of English as a Foreign Language, Educational Testing Service, Princeton, New Jersey, U.S.A.)

Admission to the institute does not imply admission to the regular session at North Carolina State University or any other branch of the University of North Carolina.

The institute, which is presented by the Division of Continuing Education in cooperation with the Summer Sessions and the Department of Modern Languages, is under the direction of Dr. George W. Poland, head of the Department of Modern Languages. All classroom work will be conducted in Harrelson Hall on the University campus. Classes including language laboratory work, will be held six hours a day, Monday through Friday, from 9:00 a.m. to 12:00 noon and from 2:00 p.m. to 5:00 p.m. Attendance at the institute does not carry academic credit.

The total cost of the six-weeks program is estimated to be approximately \$400.00. A limited amount of financial aid may be available. The cost is estimated on the basis of campus dormitory accommodations and meals at the campus cafeterias. Incidental personal expenses, such as laundry, dry cleaning, entertainment, and so forth, are not included. (Room rent includes sheets and towels.)

Tuition, books and fees	\$200.00
Room in on-campus dormitory	66.00
Food (estimated)	135.00

For further information about the institute write to Mr. Kelly R. Crump, Coordinator, Division of Continuing Education, 124-1911 Building, North Carolina State University, Raleigh, North Carolina 27607.

SEMINAR FOR COLLEGE MUSIC METHODS TEACHERS

August 26-August 29

**Theme: "A Unified Program of Music
for Prospective Teachers"**

The seminar will include a conceptual approach to music teaching, administrative aspects of a planned curriculum, and policies governing the role of the music specialist in the schools of North Carolina.

Admission by invitation.

This program is sponsored jointly by the North Carolina State Arts Council, the North Carolina Department of Public Instruction and the Division of Continuing Education of North Carolina State University.



The mall at the center of the campus with circular Harrelson Hall (left) is a major attraction at N. C. State.

COURSE LISTINGS

Courses are listed by department, IBM symbol and numerical designator. Semester hour credits for each course are given following the name of the course. An "X" after the semester hours indicates that the course carries no college credit. Classes meet daily, Monday through Friday, except where specified to the contrary. The symbols "LR" and "LB" before the clock hours refer to lecture-recitation and laboratory hours, respectively. If there is no symbol before the clock hours, lecture-recitation is implied.

Courses numbered from 1 through 100 are preparatory courses carrying no college credit; courses in the 100, 200, 300 and 400 series are primarily designed for undergraduates; courses in the 500 series for graduates and advanced undergraduates; and courses in the 600 series for graduates only.

Please note that class meeting times are given in accordance with the international time system described on page 83.

ANIMAL SCIENCE

- | | | |
|---------|---|------------------|
| ANS 407 | ADVANCED LIVESTOCK PRODUCTION | 3 |
| | A study of the economic, nutritional, genetic, physiological and managerial factors affecting the operation of livestock enterprises.
Special three weeks session (June 24-July 12): Hours Arranged
Staff | |
| ANS 590 | TOPICAL PROBLEMS IN ANIMAL SCIENCE | Maximum 6 |
| | Special problems may be selected or assigned in various phases of animal science.
Both Sessions: Hours Arranged
Staff | |
| ANS 699 | RESEARCH IN ANIMAL SCIENCE | Credits Arranged |
| | Both Sessions: Hours Arranged | Staff |

ANTHROPOLOGY

(Also see Sociology, page 76.)

- | | | |
|---------|---|---|
| ANT 252 | CULTURAL ANTHROPOLOGY | 3 |
| | The analysis of various living societies and their cultures in terms of social adjustment to recurrent needs. | |

First Session: 11:40-13:10
Second Session: 9:50-11:20

Staff

BIOCHEMISTRY

- BCH 695 SPECIAL TOPICS IN BIOCHEMISTRY Credits Arranged
Prerequisites: Graduate standing in biochemistry
Critical study of special problems in modern biochemistry.
Both Sessions: Hours Arranged Graduate Staff
- BCH 699 BIOCHEMICAL RESEARCH Credits Arranged
Both Sessions: Hours Arranged Graduate Staff

BIOLOGICAL AND AGRICULTURAL ENGINEERING

- BAE 590 SPECIAL PROBLEMS Credits Arranged
Prerequisite: Senior or graduate standing
Each student will select a subject on which he will do research and write a technical report on his results. He may choose a subject pertaining to his particular interest in any area of study in biological and agricultural engineering.
Both Sessions: Hours Arranged Staff
- BAE 699 RESEARCH IN BIOLOGICAL AND AGRICULTURAL
ENGINEERING Credits Arranged
Prerequisite: Graduate standing in biological and agricultural engineering
A maximum of six credits is allowed toward a master's degree; no limitation on credits for doctoral program.
Performance of a particular investigation of concern to biological and agricultural engineering. The study will begin with the selection of a problem and culminate with the presentation of a thesis.
Both Sessions: Hours Arranged Graduate Staff

BIOLOGICAL SCIENCES, INSTITUTE OF

- BS 100 GENERAL BIOLOGY 4
This course is designed to emphasize the unity of biology through study of the following concepts: (1) protoplasmic and cellular organization, (2) growth and differentiation, (3) genetic and ecological control and (4) evolution.
First Session: LR 8:00-9:30; LB 13:40-16:50 MTWTh or F
Nagle, Miller, Staff
- BS 470 FOUNDATIONS OF MODERN BIOLOGY 3
Prerequisites: Eighteen hours biological sciences
This course is designed to incorporate recent information and con-

cepts into a uniform approach to living systems.

Special six weeks session (June 17-July 26): LR 7:30-9:00 MTThF;
LB 13:40-16:50 M or T

Miller, Staff

BS 475 CELL BIOLOGY 3

Prerequisites: Eighteen hours biological sciences

This course will present a study of the biochemical and physical bases of cellular structure and function.

Special six weeks session (June 17-July 26): LR 9:50-11:20;
LB 13:40-16:50 Th or F

Roberts, Staff

BOTANY

BS 100 GENERAL BIOLOGY 4
(See Biological Sciences, page 24.)

BO 590 TOPICAL PROBLEMS 1-3

Prerequisite: Consent of instructor

Discussions and readings on problems of current interest in the fields of ecology, anatomy and morphology, taxonomy, and cell biology. Arrangements must be made in advance with a staff member.

Both Sessions: Hours Arranged Graduate Staff

BO 693 SPECIAL PROBLEMS IN BOTANY Credits Arranged

Directed research in some specialized phase of botany other than a thesis problem but designed to provide experience and training in research. Arrangements must be made in advance with a staff member.

Both Sessions: Hours Arranged Graduate Staff

BO 699 RESEARCH Credits Arranged

Both Sessions: Hours Arranged Graduate Staff

CERAMIC ENGINEERING

MIC 210 CERAMIC MATERIALS AND PROCESSES 3

Designed for students not majoring in ceramic engineering. Properties and applications of ceramic materials are covered with emphasis on developing selection guidelines for uses in electrical, nuclear, mechanical and chemical applications.

First Session: 9:50-11:20 Staff

MIC 509 HIGH VACUUM TECHNOLOGY 3

Prerequisite: CH 433 or MAE 301

Properties of low-pressure gases and vapors. Production, maintenance and measurement of high vacuum; design, construction and operation of high-vacuum, high-temperature facilities. Properties and reactions of materials which are processed, tested and/or utilized in high-vacuum environments.

Second Session: 7:30-9:00 Manning

MIC 596	ADVANCED CERAMIC EXPERIMENTS	3
	<i>Prerequisite: MIC 430 or equivalent</i>	
	Advanced studies in ceramic laboratory experimentation.	
	First Session: Hours Arranged	Staff
MIC 597	ADVANCED CERAMIC EXPERIMENTS	3
	<i>Prerequisite: MIC 430 or equivalent</i>	
	Advanced studies in ceramic laboratory experimentation.	
	Second Session: Hours Arranged	Staff
MIC 621	THE VITREOUS STATE	3
	<i>Prerequisite: MIC 540</i>	
	An advanced study of the structure of binary and ternary silicate and borate glasses. Influence of structure on properties of vitreous systems.	
	First Session: 7:30-9:00	Manning
MIC 636	ELECTRONIC CERAMICS	3
	<i>Prerequisites: MA 441, PY 407 or PY 414 or EE 531</i>	
	Lattice energy, dielectric and optical properties of insulators, ferroelectrics, magnetic oxides, electron distribution in insulators and semiconductors, electronic properties of alkali halides.	
	Second Session: 7:30-9:00	Stadelmier
MIC 699	CERAMIC RESEARCH	Credits Arranged
	Both Sessions: Hours Arranged	

CHEMICAL ENGINEERING

CHE 497	CHEMICAL ENGINEERING PROJECTS	2
	Elective for seniors in chemical engineering.	
	Both Sessions: Hours Arranged	Staff
CHE 597	CHEMICAL ENGINEERING PROJECTS	1-3
	<i>Prerequisite or corequisite: CHE 312</i>	
	Both Sessions: Hours Arranged	Staff
CHE 690	READINGS IN CHEMICAL ENGINEERING	Credits Arranged
	Both Sessions: Hours Arranged	Staff
CHE 699	RESEARCH	Credits Arranged
	Both Sessions: Hours Arranged	Staff

CHEMISTRY

CH 101	GENERAL CHEMISTRY I	4
	Fundamental concepts in chemistry, including atomic and molecular structure, states of aggregation of matter, chemical reactions and stoichiometry. Should be followed by CH 103 or 107.	
	Both Sessions: LR 8:00-9:30; LB 13:40-17:50 MW	Staff

CH 103	GENERAL CHEMISTRY II	4
	<i>Prerequisite: CH 101</i>	
	A continuation of CH 101, designed as a terminal course in chemistry and for students in curricula which do not require full year chemistry courses beyond the freshman level. The major part of the course is devoted to a survey of descriptive inorganic, organic and nuclear chemistry.	
	Both Sessions: LR 9:50-11:20; LB 13:40-17:50 TT	Staff
CH 107	PRINCIPLES OF CHEMISTRY II	4
	<i>Prerequisite: CH 101 with a grade of C or better</i>	
	A continuation of CH 101, designed for students who plan to take full-year courses in advanced chemistry and for any qualified student desiring a more quantitative course than CH 103. The major part of the course is devoted to the detailed quantitative aspects of stoichiometry, kinetics, equilibrium and electrochemistry, and the treatment of chemical reactions in terms of acid-base concepts.	
	First Session: LR 9:50-11:20; LB 13:40-17:50 TT	Staff
CH 215	QUANTITATIVE ANALYSIS	4
	<i>Prerequisite: CH 103 or CH 107</i>	
	A one-semester course in volumetric and gravimetric analysis including techniques, stoichiometry and principles of neutralization, oxidation-reduction and precipitation methods.	
	First Session: LR 9:50-11:20; LB 13:40-17:50 TT	Staff
CH 220	INTRODUCTORY ORGANIC CHEMISTRY	4
	<i>Prerequisite: CH 103 or CH 107</i>	
	An introduction to the fundamental principles of organic chemistry included in the study of the hydrocarbons, alcohols, ethers, aldehydes, ketones, acids and their derivatives, esters, phenols, fats, carbohydrates, amino acids, proteins, and a selected group of natural and synthetic products.	
	First Session: LR 8:00-9:30; LB 13:40-17:50 TT	Staff
CH 221	ORGANIC CHEMISTRY I	4
	<i>Prerequisite: CH 107</i>	
	Fundamentals of organic chemistry including a study of hydrocarbons, nucleophilic displacement and elimination reactions, alcohols, ethers, and carbonyl reactions. Should be followed by CH 223.	
	First Session: LR 8:00-9:30; LB 13:40-17:50 MW or TT	Staff
CH 223	ORGANIC CHEMISTRY II	4
	<i>Prerequisite: CH 107</i>	
	A continuation of CH 221 including a study of carboxylic acids and derivatives, carbohydrates, organic nitrogen compounds, and aromatic compounds.	
	Second Session: LR 8:00-9:30; LB 13:40-17:50 MW or TT	Staff
CH 231	INTRODUCTORY PHYSICAL CHEMISTRY	4
	<i>Prerequisite: CH 103 or CH 107</i>	

Designed for students whose background in mathematics and physics is not sufficient to meet the requirements of CH 431-433, but who desire instruction on chemical principles in addition to that provided at the freshman level.

First Session: LR 9:50-11:20; LB 13:40-17:50 MW

Staff

CH 431 PHYSICAL CHEMISTRY I 3

Prerequisites: CH 107, MA 202, PY 207 or PY 208

Corequisite: MA 301

States of matter, thermodynamics, and physical and chemical equilibrium. Should be followed by CH 433 and/or CH 435.

First Session: 8:00-9:30

Staff

CH 433 PHYSICAL CHEMISTRY II 3

Prerequisite: CH 431, MA 301

A continuation of CH 431, emphasizing properties of solutions, electrochemistry and reaction kinetics.

Second Session: 8:00-9:30

Staff

CH 490 CHEMICAL PREPARATIONS 3

Prerequisite: Three years chemistry

Lectures and laboratory work in preparative chemistry. Synthetic procedures will be selected to illustrate advanced methods and techniques in both inorganic and organic chemistry.

Both Sessions: Hours Arranged

Staff

CH 499 SENIOR RESEARCH 1-3

Prerequisite: Three years chemistry

An introduction to research. Independent investigation of a research problem under the supervision of a member of the chemistry faculty.

Both Sessions: Hours Arranged

Staff

CH 695 SPECIAL TOPICS IN CHEMISTRY Maximum 3

Prerequisite: Consent of head of department

A course in nuclear magnetic resonance. The use of NMR as a present-day research tool will be stressed.

First Session: 9:50-11:20

Moreland

CH 699 CHEMICAL RESEARCH Credits Arranged

Prerequisite: Graduate standing in chemistry

Both Sessions: Hours Arranged

Staff

CIVIL ENGINEERING

CE 201 ENGINEERING MEASUREMENTS IN SURVEYING 3

Prerequisite: MA 201

The general theory of engineering measurement, errors, significant figures, repeated observations, precision ratios and accuracy of measurements are presented. Other lecture topics include horizontal

and vertical control, stadia theory, concepts of area measurements, elements of simple curves, photogrammetry, and introduction to machine computation.

First Session: LR 8:00-9:00; LB 13:40-17:00 TTh

Staff

CE 324 STRUCTURAL ANALYSIS I 3

Prerequisite: EM 200

Corequisite: EM 301

Stress analysis of statically determinate beams and framed structures under fixed and moving loads; influence line treatment for moving loads; analysis and design of a simple truss.

First Session: LR 8:00-9:00; LB 13:40-17:00 MW

Staff

CE 332 STRUCTURAL MATERIALS II 3

Prerequisite: CE 331

Manufacture and properties of calcareous and bituminous cements and mineral aggregates. Mechanical properties of the following structural materials: Portland cement concrete, bituminous concrete, masonry materials and timber. Materials testing for research.

First Session: LR 9:10-10:10; LB 13:40-17:00 TTh

Staff

CE 526 ADVANCED STRUCTURAL ANALYSIS II 3

Prerequisite: CE 425

A study in depth of classical structural theories, including generalized stiffness and flexibility methods. Treatment of secondary stresses and highrise structures.

Second Session: Hours Arranged

CE 598 CIVIL ENGINEERING PROJECTS 1-6

Special projects in some phase of civil engineering.

Both Sessions: Hours Arranged

Staff

CE 699 CIVIL ENGINEERING RESEARCH Credits Arranged

Independent investigation of an advanced civil engineering problem; a report of such an investigation is required as a graduate thesis.

Both Sessions: Hours Arranged

Staff

COMPUTER SCIENCE

CSC 111 ALGORITHMIC LANGUAGES I 2

Corequisite: MA 102

Introduction to a problem-oriented computer language for use in problem solution using digital computers. This language currently is FORTRAN IV.

First Session: LR 10:20-11:20; LB 15:20-16:20

Staff

CSC 112 BASIC COMPUTER CONCEPTS 3

Prerequisite: CSC 111 or equivalent

Logical basis of computer structure, machine representation of numbers and characters, flow of control, instruction codes (symbolic), arithmetic and logical operations, indexing, I/O subroutines linkages, macros, number systems as related to computer operation. Operating systems for large machines.

First Session: 11:40-13:10

Staff

CSC 302 INTRODUCTION TO NUMERICAL METHODS

3

Prerequisite: CSC 111

Corequisite: MA 301

Computer techniques used to translate certain known computational algorithms into computer programs; practice in use of routines already available in the university program library. Areas of interest: linear systems of equations; curve fitting and interpolation; algorithms for differentiation; solution of nonlinear equations, and solution of ordinary differential equations. Elementary discussion of errors.

First Session: 9:50-11:20

Staff

CROP SCIENCE

CS 511 TOBACCO TECHNOLOGY

2

Prerequisite: CS 311, BO 421 or equivalent

A study of special problems concerned with the production of flue-cured tobacco. The latest research problems and findings dealing with this \$500 million cash crop in North Carolina will be discussed.

Special two weeks session (June 24-July 5): 8:00-11:00

Staff

CS 542 (GN 542, HS 542) PLANT BREEDING FIELD PROCEDURES

2

Prerequisite: CS 541 (GN 541, HS 541)

Conducted on an arranged basis during the entire summer, terminating approximately Sept. 15. Students should register for the course First Session noting it as a 12-week course.

Staff

CS 591 SPECIAL PROBLEMS

Credits Arranged

Prerequisite: Consent of instructor

Both Sessions: Hours Arranged

Staff

CS 699 RESEARCH

Credits Arranged

Prerequisite: Graduate standing

Both Sessions: Hours Arranged

Staff

DESIGN

(These courses start First Session and run for nine weeks.)

DN 102 ENVIRONMENTAL DESIGN II

4

Prerequisite: DN 101

Required of first year students in the School of Design.

Investigation of the sensory environment as a design determinant. Emphasis centered on individual discovery by the student who must function in problem formulating and problem solving processes. Course designed to develop technical skills simultaneously with development of conceptual models.

Special nine weeks session: 13:40-17:50

Staff

DN 112 PERCEPTION AND COMMUNICATION II 2

Prerequisite: DN 111

Required of first year students in the School of Design.

Studies designed to increase perceptual awareness and communication skills through exercises in various communications media.

Special nine weeks session: 13:40-16:50 MWF

Staff

DN 212 VISUAL COMMUNICATION II 2

Prerequisite: DN 211

Required of second year students in the School of Design.

Visual communications processes as they support design activities. Two- and three-dimensional studies as related to conceptual and definitive aspects of the design process. Exercises aimed at developing a mastery of both technical and nontechnical methods of visual communication.

Special nine weeks session: 13:40-16:50 MWF

Staff

DN 312 ADVANCED VISUAL LABORATORY II 2

Extension of problems introduced in first and second year drawing on a more advanced level. Problems will involve the human figure and its environment and investigate techniques to increase the ability of the student to express his ideas in varied forms.

Special nine weeks session: 13:40-16:50 MWF

Staff

ECONOMICS

EC 205 ECONOMIC ACTIVITY 3

An introductory study of economic activity with emphasis on national economic problems.

Both Sessions: 8:00-9:30, 9:50-11:20, 12:00-13:30

Staff

EC 206 THE PRICE SYSTEM 3

An introductory study of the determination of prices, wages and value; an analysis of the process and principles by which an economy allocates resources.

Both Sessions: 12:00-13:30

Staff

EC 301 PRODUCTION AND PRICES 3

Prerequisite: EC 206 or EC 212

An intensive study of the functioning of the market economy. An examination of the role of prices in determining the allocation of

resources, the functioning of the firm in the economy, and forces governing the production of economic goods.

Both Sessions: 9:50-11:20

Staff

- EC 302 NATIONAL INCOME AND ECONOMIC WELFARE 3**
Prerequisite: EC 205
An intensive examination of factors determining the national income. The economic and social effects of the level, composition and distribution of national income will be studied with reference to theories of economic welfare and to public policy.
Both Sessions: 8:00-9:30 Ufen, Nash
- EC 310 ECONOMICS OF THE FIRM 3**
Prerequisite: EC 205 or EC 206 or EC 212
An examination of the economic setting within which the business firm makes decisions, and an application of economic analysis to these decisions. Economics from the focal point of managerial decision-making.
Both Sessions: 7:30-9:00 Cooper
- EC 312 ACCOUNTING I 3**
Introductory and problem materials designed to provide an understanding of accounting data, its accumulation and measurements as a tool of applied economics and its employment by management.
First Session: 8:00-9:30, 13:40-15:10, 15:20-16:50 Staff
Second Session: 9:50-11:20
- EC 313 ACCOUNTING II 3**
Prerequisite: EC 312
A second semester course in accounting with emphasis on managerial use in decision-making. Concepts and methods pertinent to the accumulation, organization and interpretation of data useful in evaluating, planning and controlling the performances of the business enterprise.
Second Session: 13:40-15:10 Staff
- EC 317 INTRODUCTION TO METHODS OF ECONOMIC ANALYSIS 3**
Prerequisite: EC 301
This course treats the fundamentals of quantitative methods and economic models in the application to economic and industrial problems. Through the study of economic variables and their parameters this course lays the groundwork for later study of firm and consumer behavior.
First Session: 15:20-16:50 Staff
- EC 407 BUSINESS LAW I 3**
Prerequisite: EC 205 or EC 206 or EC 212
A course dealing with elementary legal concepts, contracts, agency, negotiable instruments, sales of personal property and insurance. Uniform commercial code considered under all titles applicable.
Both Sessions: 8:00-9:30 Staff

- EC 409 INTRODUCTION TO PRODUCTION COST 3**
Prerequisite: EC 312
 An introduction to accounting for manufacturing, fabrication and construction-type enterprises. The determination and allocation of costs of materials, labor and overhead. Special emphasis is placed on managerial analysis, interpretation and control of cost data.
 First Session: 9:50-11:20 Thompson
- EC 411 MARKETING METHODS 3**
Prerequisite: EC 205, EC 206 or EC 212
 Marketing institutions and their functions and agencies: retailing, market analysis, problems in marketing.
 Special three weeks session (June 24-July 12): Hours Arranged Staff
- EC 420 CORPORATION FINANCE 3**
Prerequisites: EC 205 and EC 312
 Financial instruments and capital structure; procuring funds; managing working capital; managing corporate capitalization; financial institutions and their work.
 First Session: 9:50-11:20 Ufen
- EC 425 INDUSTRIAL MANAGEMENT 3**
Prerequisite: Junior standing
 Principles and techniques of modern scientific management; relation of finance, marketing, industrial relations, accounting, and statistics to production planning and control; analysis of economic, political and social influences on production.
 First Session: 7:30-9:00 Wood
- EC 426 PERSONNEL MANAGEMENT 3**
Prerequisite: Junior standing
 The scientific management of manpower, from the viewpoint of the supervisor and the personnel specialists. A study of personnel policy and a review of the scientific techniques regarding the specific problems of employment, training, personnel actions, employee service and joint relations.
 First Session: 9:50-11:20 Wood
- EC 431 LABOR ECONOMICS 3**
Prerequisite: EC 301 recommended but not required
 An economic approach to the labor market and to labor problems including unemployment and the determination of wages.
 First Session: 9:50-11:20 Hausman
- EC 432 INDUSTRIAL RELATIONS 3**
Prerequisite: EC 205 or EC 212
 Collective bargaining. Analysis of basic labor law and its interpretation by the courts and governmental agencies. An examination of specific terms of labor contracts and their implications for labor and

management.
Second Session: 12:00-13:30

Bartley

- EC 490 SENIOR SEMINAR IN ECONOMICS 3
Prerequisites: EC 301 and EC 302
The terminal course in undergraduate study of economics. The student is assisted in summarizing his training, and in improving his capacity to recognize problems and to select logically consistent means of solving problems. This is done on a small-group and individual basis.
First Session: 12:00-13:30 Staff
- EC 491 SENIOR SEMINAR IN ECONOMICS 3
Prerequisites: EC 301 and EC 302
A continuation of EC 490.
Second Session: 9:50-11:20 Staff
- EC 501 PRICE THEORY 3
Prerequisite: EC 301
An intensive analysis of the determination of prices and of market behavior, including demand, cost and production, pricing under competitive conditions, and pricing under monopoly and other imperfectly competitive conditions.
Second Session: 13:40-15:10 Staff
- EC 502 INCOME AND EMPLOYMENT THEORY 3
Prerequisite: EC 302
A study of the methods and concepts of national income analysis with particular reference to the role of fiscal and monetary policy in maintaining full employment without inflation.
Special 8½ weeks session (June 5-August 2): Hours Arranged Staff
- EC 523 PLANNING FARM AND AREA ADJUSTMENTS 3
Prerequisite: EC 303
Methods and techniques of economic analysis of farm business: solution of production problems of farms; application of research findings; development of area agricultural programs.
Special three weeks session (June 24-July 12): 9:00-12:00
Bradford, Liner
- EC 533 AGRICULTURAL POLICY 3
Prerequisite: EC 301
A review and analysis of agricultural policy and action programs of the federal government; appraisal of alternative policy proposals.
Special three weeks session (June 24-July 12): 14:00-17:00
Hoover, Mangum
- EC 598 TOPICAL PROBLEMS IN ECONOMICS Maximum 6
Prerequisite: Consent of instructor
An investigation of topics of particular interest to advanced students

under the direction of a faculty member on a tutorial basis. Content will vary with the needs of students.

Both Sessions: Hours Arranged Staff

EC 603 HISTORY OF ECONOMIC THOUGHT 3

Prerequisite: EC 501 and EC 502 or equivalent

A systematic analysis of the development and cumulation of economic thought, designed to improve the understanding of contemporary economics.

Special 8½ weeks session (June 5-Aug. 2): Hours Arranged Staff

EC 650 ECONOMIC DECISION THEORY 3

Prerequisites: EC 501 or equivalent and EC 550 or EC 555

Study of general theories of choice. Structure of decision problems, the role of information; formulation of objectives. Current research problems.

Second Session: 8:00-9:30

Harrell

EC 699 RESEARCH IN ECONOMICS Credits Arranged

Prerequisite: Graduate standing

Individual research in economics, under staff supervision and direction.

Both Sessions: Hours Arranged

Staff

EDUCATION

ED 100 INTRODUCTION TO INDUSTRIAL EDUCATION 2

The place of vocational education in a program of public education and the fundamental principles upon which this work is based.

Special three weeks session (June 5-24): 8:00-11:00 MTWTh

Special three weeks session (July 17-August 5): 8:00-11:00 MTWTh
Miller

ED 304 (PHI 304) PHILOSOPHY OF EDUCATION 3

Implications of various philosophical viewpoints, especially in value theory, social-political philosophy, and theory of knowledge, for the aims and procedures of education; study of the relevant work of the principal contributors to the Western intellectual tradition from Plato to the present.

Second Session: 8:00-9:30

Middleton

ED 344 SECONDARY EDUCATION 3

Prerequisite: Junior standing

An overview of secondary education, including development, problems, services, trends, teaching profession, role of school in the community; purposes and objectives; the development and status of secondary education in North Carolina.

First Session: 9:50-11:20

Visiting Professor

ED 405 INDUSTRIAL AND TECHNICAL EDUCATION SHOP AND LABORATORY PLANNING 3

Prerequisites: Senior standing, six hours drawing or design
 Principles and techniques to assist teachers in planning and organizing shop and laboratory facilities.
 Special three weeks session (June 25-July 12): 8:00-11:00 Shore

- ED 421 PRINCIPLES AND PRACTICES IN INDUSTRIAL COOPERATIVE TRAINING 3
Prerequisites: ED 327, ED 344
 A study of the developments, objectives and principles of industrial cooperative training.
 Special three weeks session (June 5-24): 8:00-11:00 Smith
- ED 422 METHODS OF TEACHING INDUSTRIAL SUBJECTS 4
Prerequisites: ED 344, PSY 304
 A study of effective methods and techniques of teaching industrial subjects. Emphasis is given to class organization; methods of teaching manipulative skills and related information; lesson planning; shop safety; and evaluation.
 Special three weeks session (June 5-24): 8:00-12:00 Shore
- ED 428 ORGANIZATION OF RELATED STUDY MATERIALS 3
Prerequisites: ED 327, ED 344
 The principles of selecting and organizing both technical and general related instructional material for trade extension and industrial cooperative training classes.
 Special three weeks session (June 25-July 12): 8:00-11:00 Smith
- ED 440 VOCATIONAL EDUCATION 2
Prerequisites: ED 344, PSY 304
 A comprehensive study of the types of vocational education of less than college grade, provided for through federal legislation; and an evaluation of the effectiveness of the program.
 Special three weeks session (June 5-June 24): 8:00-11:00 MTWTh
 Visiting Professor
- ED 444 STUDENT TEACHING IN INDUSTRIAL SUBJECTS 6
Prerequisite: ED 422
 First Session: Hours Arranged Staff
- ED 483 INSTRUCTIONAL AIDS AND DEVICES 2
Prerequisites: PSY 304 or six hours education
 Analysis of learning units and the preparation of instructional aids and devices.
 Special three weeks session (June 5-June 24): 10:20-11:50 MTWTh
 Miller
- ED 503 THE PROGRAMMING PROCESS IN ADULT EDUCATION 3
Prerequisites: ED 501, consent of instructor
 The principles and processes involved in programming, including basic theories and concepts supporting the programming process. Attention will be given to the general framework in which programming is

done, the organization needed, and the program roles of both professional and lay leaders.

Special three weeks session (June 24-July 12): Hours Arranged
Boone

- ED 504** **PRINCIPLES AND PRACTICES OF INTRODUCTION TO VOCATIONS** **3**
Prerequisites: Twelve hours education
The course is designed for teachers of Introduction to Vocations in the public schools. Emphasis will be placed on the IV program in the overall school curriculum, special methods of instruction, use of teaching aids and use of student evaluation instruments.
First Session: 9:50-11:20 Clary, Cox
- ED 505** **PUBLIC AREA SCHOOLS** **3**
Prerequisite: Graduate standing
Junior and community colleges, technical institutes, vocational schools and branches of universities: their development, status and prospects; policy and policy making, clientele, purposes, evaluation programs, personnel, organization, administration, financing, facilities, research and development functions.
Second Session: Hours Arranged Adams
- ED 506** **EDUCATION OF EXCEPTIONAL CHILDREN** **3**
Prerequisites: Six hours education or psychology
Discussion of principles and techniques of teaching the exceptional child with major interest on the mentally handicapped and slow learner. Opportunity for individual work with an exceptional child will be provided.
Second Session: Hours Arranged McCutchen
- ED 507** **ANALYSIS OF READING ABILITIES** **3**
Prerequisites: Six hours education or psychology
A study of tests and techniques in determining specific abilities; a study of reading retardation and factors underlying reading difficulties.
First Session: 8:00-9:30 Rust
- ED 508** **IMPROVEMENT OF READING ABILITIES** **3**
Prerequisites: Six hours education or psychology
A study of methods used in developing specific reading skills or in overcoming certain reading difficulties; a study of methods used in developing pupil vocabularies and word analysis skills; a study of how to control vocabulary burden of reading material.
First Session: 9:50-11:20 Rust
- ED 509** **METHODS AND MATERIALS—TEACHING RETARDED CHILDREN** **3**
Prerequisite: ED 506
A study of appropriate educational methods and materials for mentally retarded children.
Second Session: Hours Arranged McCutchen

- ED 510 ADULT EDUCATION: HISTORY, PHILOSOPHY, CONTEMPORARY NATURE 3
Prerequisite: Graduate standing
 A study of the historical and philosophical foundations of adult education from ancient times to the present, giving attention to key figures, issues, institutions, movements and programs including consideration of the relationship between adult education's historical development and prevailing intellectual, social, economic and political conditions. Consideration of adult education's contemporary nature, present day schools of thought on its objectives, and trends. Examination of the relationship between means and ends in adult education.
 First Session: 9:50-11:20 Russell
- ED 516 COMMUNITY OCCUPATIONAL SURVEYS 2
Prerequisites: Six hours education, consent of instructor
 Methods in organizing and conducting local surveys and evaluation of findings in planning a program of vocational education.
 First Session: 9:50-11:20 MTWTh Hanson
- ED 520 PERSONNEL AND GUIDANCE SERVICES 3
Prerequisites: Six hours education or psychology
 An introduction to the philosophies, theories, principles and practices of personnel and guidance services.
 Both Sessions: 8:00-9:30 Morehead
- ED 524 OCCUPATIONAL INFORMATION 3
Prerequisites: Six hours education or psychology, ED 520 or equivalent
 To give teachers and counselors an understanding of how to collect, classify, evaluate, and use occupational and educational information.
 First Session: 8:00-9:30 Clary
- ED 527 PHILOSOPHY OF INDUSTRIAL AND TECHNICAL EDUCATION 3
Prerequisites: ED 422, ED 440
 A presentation of the historical development of industrial and technical education; the types of programs, philosophy, trends and problems of vocational-industrial education; study of federal and state legislation pertaining to industrial and technical education.
 First Session: 8:00-9:30 Nerden
- ED 530 GROUP GUIDANCE 3
Prerequisites: Six hours education or psychology, ED 520 or equivalent
 To help teachers, counselors, administrators and others who are responsible for group guidance activities, to understand the theory and principles of effective group work.
 First Session: 9:50-11:20 Morehead
- ED 533 ORGANIZATION AND ADMINISTRATION OF GUIDANCE SERVICES 3
Prerequisites: Graduate standing, ED 520 or equivalent

For school guidance counselors, prospective counselors, personnel and guidance directors, and school administrators. The philosophy and scope of guidance and personnel services; the functions and responsibilities of personnel involved; basic principles and current practices in planning, developing, operating, and supervising guidance and personnel services will be studied.

First Session: 8:00-9:30

Hopke

ED 554 PLANNING PROGRAMS IN AGRICULTURAL EDUCATION 3

Prerequisite: ED 411 or equivalent

A three semester-hour course to assist teachers in planning local vocational agriculture programs in multiteacher departments or re-organized school districts.

Special three weeks session (June 24-July 12): Hours Arranged

Bryant

ED 559 PRINCIPLES OF ADULT EDUCATION 3

Prerequisites: Six hours education

Principles involved in adult education programs including theories and concepts undergirding and requisite to these programs. Emphasis will be given to the interrelationship of the nature of the subject matter and the setting in which learning occurs. The applicability of relevant principles and pertinent research findings to adult learning will be thoroughly treated.

Special three weeks session (June 24-July 12): Hours Arranged

Quinn

ED 560 (IA 560) NEW DEVELOPMENTS IN INDUSTRIAL ARTS EDUCATION 3

Prerequisites: Twelve hours education and teaching experience

This course is a study of the new developments in industrial arts education. It is designed to assist teachers and administrators in developing new concepts and new content based on the changes in technology.

First Session: 8:00-9:30

Olson

ED 563 EFFECTIVE TEACHING 3

Prerequisites: Twelve hours education including student teaching

Analysis of the teaching-learning process; assumptions that underlie course approaches; identifying problems of importance; problem solution for effective learning; evaluation of teaching and learning, making specific plans for effective teaching.

First Session: 8:00-9:30

Hollis

ED 590-1 INDIVIDUAL PROBLEMS IN GUIDANCE (Guidance in Elementary Schools) 3

Prerequisites: Six hours graduate credit or equivalent

An examination of current theory, philosophy and practice in elementary school guidance and the role of the elementary school counselor.

First Session: 8:00-9:30

Parramore

- ED 590-2 INDIVIDUAL PROBLEMS IN GUIDANCE (Student Personnel Work in Higher Education) 3**
Examines current practices in various areas of student personnel work; studies both structure and functions of personnel programs in higher education.
First Session: 8:00-9:30 Anderson
- ED 590-3 INDIVIDUAL PROBLEMS IN GUIDANCE (Advanced Counselor Workshop in Career Development) 3**
A special two weeks session for counselors selected by the State Department of Education.
Special two weeks session (July 15-July 26): 8:30-16:30 Hopke
- ED 591 SPECIAL PROBLEMS IN INDUSTRIAL EDUCATION Maximum 6**
Prerequisites: Six hours graduate credit, consent of department head
Directed study to provide individualized study and analysis in specialized areas of trade, industrial or technical subjects.
Both Sessions: Hours Arranged Hanson, Nerden
- ED 592 SPECIAL PROBLEMS IN MATHEMATICS TEACHING 3**
Prerequisite: ED 471 or equivalent
Consideration of current problems in mathematics education. Opportunities provided for students to study particular problems and initiate investigations under the direction of the faculty.
First Session: Hours Arranged Speece
- ED 593 SPECIAL PROBLEMS Credits Arranged**
Prerequisite: ED 411 or equivalent
Opportunities for students in vocational agriculture to study current problems under the guidance of the staff.
Both Sessions: Hours Arranged Staff
- ED 594 SPECIAL PROBLEMS IN SCIENCE TEACHING 3**
Prerequisite: ED 476 or equivalent
Consideration of current problems in science education. Opportunities provided for students to study particular problems and initiate investigations under the direction of the faculty.
First Session: Hours Arranged Speece
- ED 595 (IA 595) INDUSTRIAL ARTS WORKSHOP 3**
Prerequisite: One or more years of teaching experience
A course for experienced teachers, administrators and supervisors of industrial arts. The primary purpose will be to develop sound principles and practices for initiating, conducting and evaluating programs in the field.
Second Session: 9:50-11:20 Young
- ED 596 TOPICAL PROBLEMS IN ADULT EDUCATION 3**
Study and scientific analysis of problems in adult education, and preparation of a scholarly research type of paper.

Both Sessions: Hours Arranged

Special three weeks session (June 24-July 12): Hours Arranged
Graduate Staff

- ED 600 THEORY OF ORGANIZATION AND ADMINISTRATION IN ADULT
EDUCATION I (Emphasis on Organization) 3
Prerequisites: ED 503, PS 502
Theory of organization relating to adult education social systems as
a basis for understanding administrative behavior. An in depth
analysis of the structure, function and process of adult education
social systems, patterns of organizational growth and change, be-
havior patterns of functionaries, and reciprocal influence of the
adult education system and other social systems in the society.
Special three weeks session (June 24-July 12): Hours Arranged
Dolan
- ED 601 THEORY OF ORGANIZATION AND ADMINISTRATION IN ADULT
EDUCATION II (Emphasis on Administration) 3
*Prerequisite: ED 600 or a comparable course(s) on organizational
theory*
Theory and principles of complex organization relating to adult
education systems. A depth analysis is made of the structure, func-
tion and process of adult education organizations, patterns of or-
ganizational growth and change, behavior patterns of functionaries
within the organization and reciprocal influence of the adult educa-
tion organization and society.
Special three weeks session (June 24-July 12): Hours Arranged
Boone, Ferguson
- ED 611 LAWS, REGULATIONS AND POLICIES AFFECTING VOCATIONAL
EDUCATION 3
Prerequisites: ED 527, ED 610 or equivalent
A detailed study of legislation (national and state) which applies
directly to occupational education.
First Session: 9:50-11:20
Nerden
- ED 615 INTRODUCTION TO EDUCATIONAL RESEARCH 3
Prerequisite: PSY 535 or equivalent
The course is designed to assist the student in understanding the
meaning and purpose of educational research; and to develop the
student's ability to identify educational problems, and to plan and
carry out research to solve these problems.
First Session: 8:00-9:30
Brown
- ED 633 TECHNIQUES OF COUNSELING 3
*Prerequisites: Nine hours economics, education, psychology or
sociology*
To aid the personnel worker in developing an understanding of and
skill in counseling techniques; philosophies, theories, principles and
practices of counseling will be considered.
First Session: 9:50-11:20
Hopke

ED 641	LABORATORY AND PRACTICUM EXPERIENCES IN COUNSELING	3
	<i>Prerequisite: Advanced graduate standing</i>	
	A practicum course in which the student participates in actual counseling experience under supervision.	
	First Session: 9:50-11:20	Anderson
	Second Session: 9:50-11:20	Morehead
ED 691	SEMINAR IN INDUSTRIAL EDUCATION	1
	<i>Prerequisite: Graduate standing or consent of instructor</i>	
	Reviews and reports of topics of special interest to graduate students in industrial education.	
	First Session: Hours Arranged	Visiting Professor
ED 695	SEMINAR IN SCIENCE EDUCATION	Maximum 2
	<i>Prerequisite: Departmental major or consent of instructor</i>	
	A critical analysis of issues, trends and recent developments in science education.	
	First Session: Hours Arranged	Anderson
ED 699	RESEARCH	Credits Arranged
	<i>Prerequisites: Fifteen hours, consent of advisor</i>	
	Individual research on a specific problem of concern to the student.	
	Both Sessions: Hours Arranged	Graduate Staff

ELECTRICAL ENGINEERING

EE 202	ELECTRIC CIRCUITS II	4
	<i>Prerequisites: EE 201, MA 201</i>	
	A continuation of EE 201. Circuit analysis by complex frequency. Introduction to two-port networks and polyphase circuits. Problem drill and laboratory exercises. (Offered only in a 12-week sequence. The course counts for two semester hours in calculating loads for each session. Students should register for two semester hours at registration for each session, noting the 12-week sequence on their rosters.)	
	Both Sessions: LR 8:00-9:00, 9:10-10:10; LB 13:40-15:50 MW, TTh, or MTh	Seagraves
EE 213	ELECTRIC CIRCUITS I LAB	1
	<i>Prerequisite: EE 211</i>	
	First Session: LB 13:40-15:50 TTh	Seagraves
EE 332	PRINCIPLES OF ELECTRICAL ENGINEERING	4
	<i>Prerequisite: EE 331</i>	
	A continuation of EE 331.	
	First Session: LR 7:30-9:00; LB 13:40-16:20 MW or TTh	

- EE 350** **ELECTRIC POWER UTILIZATION IN MANUFACTURING PROCESSES** **3**
Prerequisites: PY 212, MA 201
 Introduction to basic electrical theory; d-c and a-c circuits and measurements; study of d-c motors and of single-phase and polyphase utilization equipment; basic control systems and brief introduction to principles of automatic control.
 Application examples will be drawn from the technologies of particular interest to the students in the class.
 First Session: 8:00-9:30 **Staff**
- EE 615** **ELECTROMAGNETIC WAVES** **3**
Prerequisite: EE 507
 Maxwell's equations applied to a study of the propagation of energy by electromagnetic waves. Vector and scalar retarded potentials, propagation in free space and material media, guided electromagnetic waves, common waveguides, skin effects, resonant cavities. Micro-wave network theory applied to measurement problems.
 Second Session: 8:00-9:30 **Barclay**
- EE 643** **ADVANCED ELECTRICAL MEASUREMENTS** **3**
Prerequisites: EE 503, EE 431
 A critical analysis of circuits used in electrical measurements, with special attention to such topics as balance convergence, effects of strays, sensitivity, the use of feedback in electronic devices, automatic measuring systems, and digital measuring systems.
 Second Session: 9:50-11:20 **Hoadley**
- EE 691** **SPECIAL STUDIES IN ELECTRICAL ENGINEERING** **3**
 This course provides an opportunity for small groups of advanced graduate students to study, under the direction of qualified members of the professional staff, advanced topics in their special fields of interest.
 Both Sessions: Hours Arranged **Graduate Staff**
- EE 699** **ELECTRICAL ENGINEERING RESEARCH** **Credits Arranged**
Prerequisites: Graduate standing in electrical engineering, consent of advisor
 Both Sessions: Hours Arranged **Graduate Staff**

ENGINEERING GRAPHICS

- E 101** **ENGINEERING GRAPHICS I** **2**
 The theory of graphically representing and solving spatial problems. Emphasis is placed on the development of a logical and analytical approach to problem solution. Conventional methods of graphically describing size and shape are introduced. Practical engineering

design situations are presented and the student arrives at an individual solution.

First Session: 8:00-10:10, 11:40-13:50

Staff

Second Session: 7:30-9:40

E 102 ENGINEERING GRAPHICS II 1

Prerequisite: E 101

The theory of graphically representing engineering data and then solving for any relationships that exist for that data. Material presented includes vector geometry, curve fitting, rate problems and graphical calculus. Engineering design situations are presented and the student arrives at an individual solution.

First Session: 7:30-9:00, 9:50-11:20

Staff

Second Session: 9:50-11:20

E 207 ENGINEERING GRAPHICS III 2

Prerequisite: E 102

A study of the current practices of communicating exact engineering information in the graphic medium. Production dimensioning, production characteristics, free hand sketching, production changes, and detail and assembly drawings will be covered. Special emphasis is placed on the use of technical sketching. [The above will include standards and practices peculiar to mechanical, electrical (communication), construction, plant design and related fields.]

First Session: 7:30-10:10

ENGINEERING MECHANICS

EM 200 INTRODUCTION TO MECHANICS 3

Corequisite: MA 301

An introduction to the principles and concepts which form the basis for studies in dynamics, solid mechanics and fluid mechanics. The nature and properties of force systems and stress fields. The motion of particles and description of deformation of continuous media. The role of Newton's laws, the concepts of continuity and equilibrium, and the conservational principles in problems in mechanics.

Both Sessions: 8:00-9:30, 9:50-11:20

Staff

EM 211 INTRODUCTION TO APPLIED MECHANICS 3

Prerequisites: MA 102 or MA 112, PY 221

Corequisite: PY 212

This course is intended to acquaint the student with the concepts of particle and rigid body mechanics. The fundamentals of equilibrium, kinematics and kinetics are applied to engineering problems involving structures and machines.

Both Sessions: 8:00-9:30

Staff

EM 212	MECHANICS OF ENGINEERING MATERIALS	3
	<i>Prerequisite: EM 211</i>	
	This course constitutes a study of properties of engineering materials with special emphasis on the mechanical parameters. It is especially conceived to prepare the student for the selection and specification of materials common to engineering practice. A particular emphasis is given to mechanical aspects of materials employed in design.	
	Both Sessions: LR 9:50-11:20 MWF; LB 10:20-13:00 TTh	
EM 301	SOLID MECHANICS I	3
	<i>Prerequisite: EM 200</i>	
	Introduction to the mechanics of deformable solids. Development of the equations which describe the linear elastic solid. Approximate solutions and solutions governed by the theory of elasticity to problems involving prescribed force systems, states of motion or energy inputs.	
	Both Sessions: 8:00-9:30, 9:50-11:20	Staff
EM 303	FLUID MECHANICS I	3
	<i>Prerequisite: EM 200</i>	
	Development of the basic equations of fluid mechanics in general and specialized form. Application of these specialized equations to a variety of topics including fluid statics, inviscid, incompressible fluid flow, and viscous, incompressible fluid flow.	
	Both Sessions: 8:00-9:30, 9:50-11:20	Staff
EM 503	THEORY OF ELASTICITY I	3
	<i>Prerequisite: EM 301</i>	
	<i>Corequisite: MA 511 or MA 401</i>	
	The fundamental equations governing the behavior of an elastic solid are developed in various curvilinear coordinate systems.	
	First Session: 9:50-11:20	Staff
EM 698	SPECIAL TOPICS IN MECHANICS	Credits Arranged
	Both Sessions: Hours Arranged	Staff
EM 699	RESEARCH IN MECHANICS	Credits Arranged
	Both Sessions: Hours Arranged	

ENGLISH

ENG 100	REFRESHER ENGLISH	3X
	A course for students deficient in English. Special attention will be given to individual problems in grammar, reading and writing.	
	First Session: 8:00-9:30, 11:40-13:10	Staff

ENG 111	COMPOSITION AND RHETORIC	3
	Required of all freshmen.	
	Intensive study and practice in the basic forms and principles of expository communication; conferences.	
	Both Sessions: 8:00-9:30, 9:50-11:20, 11:40-13:10	Staff
ENG 112	COMPOSITION AND READING	3
	Required of all freshmen.	
	<i>Prerequisite: ENG 111</i>	
	Continued practice in expository writing; introduction to literary types; collateral reading; conferences.	
	Both Sessions: 8:00-9:30, 9:50-11:20, 11:40-13:10	Staff
<i>NOTE: The prerequisite for all advanced courses in writing, language, speech or literature is the completion of 111 and 112 with a grade of C or better in at least one semester. Desirable preparation for literature courses of the 300 level or above is ENG 205 or any semester of ENG 261-262 or ENG 265-266.</i>		
ENG 205	READING FOR DISCOVERY	3
	Selected masterworks drawn from American, English and European literature.	
	Both Sessions: 8:00-9:30, 9:50-11:20, 11:40-13:10	Staff
ENG 211	BUSINESS COMMUNICATIONS	3
	Basic types of business correspondence and written and oral reports.	
	Both Sessions: 11:40-13:10	Staff
	First Session: 8:00-9:30	Staff
ENG 261	ENGLISH LITERATURE I (Beginnings to 1790)	3
	First Session: 8:00-9:30, 11:40-13:10	Staff
ENG 262	ENGLISH LITERATURE II (1790 to present)	3
	Second Session: 9:50-11:20, 11:40-13:10	Staff
ENG 265	AMERICAN LITERATURE I (Beginnings to 1850)	3
	First Session: 9:50-11:20, 11:40-13:10	Staff
ENG 266	AMERICAN LITERATURE II (1850 to present)	3
	Second Session: 8:00-9:30, 11:40-13:10	Staff
ENG 321	THE COMMUNICATION OF TECHNICAL INFORMATION	3
	<i>Prerequisite: Junior or senior standing</i>	
	Intensive training in the fundamentals of business and industrial expository and persuasive writing.	
	Both Sessions: 9:50-11:20	Dandridge, Davis

- ENG 369 AMERICAN NOVEL OF THE NINETEENTH CENTURY 3
Analysis of selected romantic, realistic and naturalistic novels.
First Session: 9:50-11:20 Kesterson
- ENG 371 THE NOVEL 3
Analysis of selected English, American and Continental novels.
Second Session: 9:50-11:20 Kincheloe
- ENG 396 LITERATURE OF THE WESTERN WORLD 3
Selected great books from the Homeric period of Greek literature to the Renaissance in Europe.
Second Session: 11:40-13:10 White
- ENG 398 CONTEMPORARY LITERATURE 3
Selected examples of American, British and Continental writing from 1890 to the present day.
First Session: 11:40-13:10 Reynolds
- ENG 453 THE ROMANTIC PERIOD 3
The poetry of Wordsworth, Coleridge, Byron, Shelley and Keats, with readings in the prose of Lamb, DeQuincey and others.
First Session: 11:40-13:10 P. Williams
- ENG 480 MODERN DRAMA 3
Major plays from Ibsen to Albee.
Second Session: 11:40-13:10 Halperen
- ENG 485 SHAKESPEARE 3
A study of the principal plays with emphasis on the development of the playwright.
First Session: 9:50-11:20 Toole
- ENG 524 MODERN ENGLISH USAGE 3
Prerequisite: Consent of instructor or graduate standing
An intensive study of English grammar, with attention to new developments in structural linguistics and with emphasis on current usage.
Second Session: 8:00-9:30 Meyers
- ENG 551 CHAUCER 3
Prerequisite: ENG 261 or equivalent
The intensive reading and analysis of Chaucer's major works, with attention to linguistic problems.
First Session: 8:00-9:30 Koonce
- ENG 659 STUDIES IN SHAKESPEARE 3
Prerequisite: ENG 485 or equivalent and graduate standing
An intensive study—textual and critical—of Shakespeare's comedies.
First Session: 9:50-11:20 Champion

Prerequisite: Graduate standing

An examination of the critical process as it leads to the definition and analysis of literature, together with attention to the main literary traditions and conventions.

Second Session: 9:50-11:20

Halperen

ENTOMOLOGY

ENT 590 SPECIAL PROBLEMS

Credits Arranged

Prerequisites: Graduate standing, consent of instructor

Both Sessions: Hours Arranged

Staff

ENT 699 RESEARCH

Credits Arranged

Prerequisite: Graduate standing in entomology or closely allied fields

Both Sessions: Hours Arranged

Staff

FOOD SCIENCE

FS 591 SPECIAL PROBLEMS IN FOOD SCIENCE

1-3

Prerequisites: Senior or graduate standing, consent of instructor

Analysis of scientific, engineering and economic problems of current interest in foods. The scientific appraisal and solution of a selected problem. The problems are designed to provide training and experience in research.

Both Sessions: Hours Arranged

Graduate Staff

FS 691 SPECIAL RESEARCH PROBLEMS IN FOOD SCIENCE

Credits Arranged

Directed research in a specialized phase of food science designed to provide experience in research methodology and philosophy.

Both Sessions: Hours Arranged

Graduate Staff

FS 699 RESEARCH IN FOOD SCIENCE

Credits Arranged

Original research preparatory to the thesis for Master of Science or Doctor of Philosophy degrees.

Both Sessions: Hours Arranged

Graduate Staff

FOREST RESOURCES

FOR s204 SILVICULTURE

2

Sophomore Summer Camp

Prerequisite: Junior standing in FOM

First Session: 8:00-17:00

Second Session: 8:00-17:00

Duffield, Maki
Duffield, Grad. Asst.

FOR s205 WOOD MACHINING PRACTICUM

1

Sophomore Summer Practicum WT

	<i>Prerequisite: FOR 203</i>	
	Second Session: 8:00-17:00	Gilmore
FOR s206	WOOD DRYING PRACTICUM Sophomore Summer Practicum WT First Session: 8:00-17:00	1 Carter
FOR s207	GLUING PRACTICUM First Session: 8:00-17:00 Sophomore Summer Practicum WT	1 Carter, Gilmore, McNamara
FOR s208	WOOD FINISHING PRACTICUM Sophomore Summer Practicum WT First Session: 8:00-17:00	1 Carter
FOR s209	PLANT INSPECTIONS Sophomore Summer Practicum WT First Session: 8:00-17:00	1 Carter
FOR s263	DENDROLOGY Sophomore Summer Camp <i>Prerequisite: Junior standing in FOM</i> First Session: 8:00-17:00	1 Staff
FOR s264	FOREST PROTECTION Sophomore Summer Camp <i>Prerequisite: Junior standing in FOM</i> First Session: 8:00-17:00 Second Session: 8:00-17:00	2 Bryant, Cowling, Farrier Bryant, Grad. Asst.
FOR s274	MAPPING AND MENSURATION Sophomore Summer Camp <i>Prerequisite: Junior standing in FOM</i> First Session: 8:00-17:00	4 Lammi, Steensen, Bryant, Grad. Asst.
FOR s284	UTILIZATION Sophomore Summer Camp Second Session: 8:00-17:00	1 Staff
*FOR 491W	SENIOR PROBLEMS Sophomore Summer Practicum WT <i>Prerequisite: Senior standing</i> Second Session: Hours Arranged	Credits Arranged Carter
**FOR 491F	SENIOR PROBLEMS <i>Prerequisite: Senior standing</i> Both Sessions: Hours Arranged	Credits Arranged Staff

• Wood Technology Majors
 ** Forest Management Majors

**FOR 591F	FORESTRY PROBLEMS	Credits Arranged
	<i>Prerequisite: Senior or graduate standing in FOM</i>	
	Both Sessions: Hours Arranged	Staff
*FOR 591W	FORESTRY PROBLEMS	Credits Arranged
	<i>Prerequisite: Senior or graduate standing in WT</i>	
	Both Sessions: Hours Arranged	Staff
FOR 692	ADVANCED FOREST MANAGEMENT PROBLEMS	Credits Arranged
	<i>Prerequisite: Graduate standing</i>	
	Both Sessions: Hours Arranged	Staff
FOR 693	ADVANCED WOOD TECHNOLOGY PROBLEMS	Credits Arranged
	<i>Prerequisite: Graduate standing</i>	
	Both Sessions: Hours Arranged	Staff
*FOR 699W	PROBLEMS IN RESEARCH WT	Credits Arranged
	Both Sessions: Hours Arranged	Staff
**FOR 699F	PROBLEMS IN RESEARCH FOM	Credits Arranged
	<i>Prerequisite: Graduate standing</i>	
	Both Sessions: Hours Arranged	Staff

GENETICS

GN 301	GENETICS IN HUMAN AFFAIRS	3
	Fundamental principles of genetics will be presented at a level not requiring prerequisite courses in biological sciences but sufficient for an understanding of the relation of genetics to society and technology. A survey will be given of current knowledge of inheritance of human traits.	
	First Session: 9:50-11:20	Bostian
GN 411	THE PRINCIPLES OF GENETICS	3
	<i>Prerequisite: BS 100</i>	
	An introductory course. The physical and chemical basis of inheritance; genes as functional and structural units of heredity and development; qualitative and quantitative aspects of genetic variation.	
	First Session: 8:00-9:30	Bostian
GN 695	SPECIAL PROBLEMS IN GENETICS	1-3
	<i>Prerequisites: Advanced graduate standing, consent of instructor</i>	
	Both Sessions: Hours Arranged	Graduate Staff
GN 699	RESEARCH	Credits Arranged
	<i>Prerequisites: Graduate standing, consent of advisor</i>	
	Both Sessions: Hours Arranged	Graduate Staff

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- Wood Technology Majors
 - Forest Management Majors

HISTORY

HI 105	MODERN WESTERN WORLD	3
	Not open to students required to take HI 101, 102.	
	Both Sessions: 8:00-9:30	Nixon
HI 101	HISTORY OF CIVILIZATION (TO 1650)	3
	Required of all students in Liberal Arts unless excused by examination.	
	First Session: 8:00-9:30	Banker
	Second Session: 9:50-11:20	Nixon
HI 102	HISTORY OF CIVILIZATION (SINCE 1650)	3
	Required of all students in Liberal Arts unless excused by examination.	
	First Session: 9:50-11:20	Nixon
	Second Session: 9:50-11:20	Suval
HI 111	UNITED STATES THROUGH RECONSTRUCTION	3
	First Session: 9:50-11:20	Seegers
HI 112	UNITED STATES SINCE RECONSTRUCTION	3
	First Session: 8:00-9:30	Beers
	Second Session: 8:00-9:30	Lemmon
HI 231	VIENNA TO VERSAILLES	3
	<i>Prerequisite: Three hours history or freshmen with consent</i>	
	Second Session: 8:00-9:30	Suval
HI 264	MODERN EAST ASIA: 1800 TO PRESENT	3
	<i>Prerequisite: One semester history or advanced placement</i>	
	First Session: 9:50-11:20	Beers
HI 306	NORTH CAROLINA HISTORY	3
	<i>Prerequisite: Three hours history</i>	
	Second Session: 9:50-11:20	Lemmon
HI 344	UNITED STATES: REVOLUTION TO CONSTITUTION	3
	<i>Prerequisite: Three hours history or consent of department</i>	
	First Session: 8:00-9:30	Seegers
HI 351	ENGLISH HISTORY (TO 1688)	3
	<i>Prerequisite: Three hours history or consent of department</i>	
	First Session: 9:50-11:20	Banker

HORTICULTURAL SCIENCE

HS 432	VEGETABLE PRODUCTION	3
	<i>Prerequisite: BS 100, SSC 200</i>	
	The course is designed to cover the application of scientific principles	

to successful vegetable production on a commercial scale in North Carolina. The presently important vegetable crops, as well as those with potential commercial value, will be covered.

Special three weeks session (June 24-July 12): Hours Arranged
Banadyga

HS 599	RESEARCH PRINCIPLES	Credits Arranged
	<i>Prerequisite: Consent of instructor</i>	
	Investigation of a problem in horticulture. The students obtain practice in experimental techniques, critical review of literature and scientific writing.	
	First Session: Hours Arranged	Graduate Staff
HS 699	RESEARCH	Credits Arranged
	<i>Prerequisites: Graduate standing in horticulture, consent of advisory committee chairman</i>	
	Both Sessions: Hours Arranged	Graduate Staff

INDUSTRIAL ARTS

IA 102	FUNDAMENTALS OF MATERIALS AND PROCESSES	4
	A systematic study of the structure and characteristics of selected materials and the processes utilized in shaping, forming, cutting, machining and finishing.	
	First Session: 10:20-13:20	Finch
IA 105	DRAFTING	4
	<i>Prerequisite: IA 102</i>	
	Second Session: 7:00-10:10	Troxler
IA 209	WOOD PROCESSING	4
	<i>Prerequisite: IA 102</i>	
	This course is designed to provide an orientation to the processes of designing, developing and producing wood products through lectures, discussions and planned experiences in the various woodworking areas.	
	Second Session: 10:20-13:30	Finch
IA 210	METAL TECHNOLOGY	4
	<i>Prerequisites: IA 102, IA 105</i>	
	First Session: 7:00-10:10	Moeller
IA 230	DRAFTING II	8
	<i>Prerequisite: IA 105</i>	
	Second Session: 10:20-13:30	Troxler
IA 310	MACHINE AND FOUNDRY PRACTICUM	3
	<i>Prerequisite: IA 210</i>	
	First Session: 10:20-13:30	Moeller

IA 312	ELECTRICITY-ELECTRONICS	4
	<i>Prerequisites: PY 211, PY 212 or consent of instructor</i>	
	Second Session: 7:00-10:20	Young
IA 560	(ED 560) NEW DEVELOPMENTS IN INDUSTRIAL ARTS EDUCATION	3
	<i>Prerequisites: Twelve hours education, teaching experience</i>	
	First Session: 10:20-11:30	Olson
IA 590	LABORATORY PROBLEMS IN INDUSTRIAL ARTS	Maximum 6
	<i>Prerequisites: Senior standing, consent of instructor</i>	
	Both Sessions: Hours Arranged	Graduate Staff
IA 592	SPECIAL PROBLEMS IN INDUSTRIAL ARTS	Maximum 6
	<i>Prerequisite: One term of student teaching or equivalent</i>	
	Both Sessions: Hours Arranged	Graduate Staff
IA 595	(ED 595) INDUSTRIAL ARTS WORKSHOP	3
	<i>Prerequisite: One or more years of teaching experience</i>	
	Second Session: 10:20-11:30	Young
ED 630	PHILOSOPHY OF INDUSTRIAL ARTS	2
	<i>Prerequisite: Twelve hours education</i>	
	First Session: 8:00-9:30 MTWTh	Olson
ED 692	SEMINAR IN INDUSTRIAL ARTS EDUCATION	1
	<i>Prerequisite: Graduate standing</i>	
	Second Session: 8:00-9:30 F	Young

INDUSTRIAL ENGINEERING

IE 301	ENGINEERING ECONOMY	3
	<i>Prerequisite: Junior standing</i>	
	Criteria and techniques of engineering economy for management decisions in relation to economy of design.	
	Second Session: 8:00-9:30	Staff
IE 328	MANUFACTURING PROCESSES	3
	<i>Prerequisite: MIM 201</i>	
	The forming, finishing and joining operations used in the manufacture of industrial products of metallic and nonmetallic materials are treated.	
	Second Session: LR 10:20-11:30; LB 13:40-16:20 MWF	Harder
IE 332	MOTION AND TIME STUDY	4
	<i>Prerequisite: ST 361</i>	
	Principles and techniques of motion and time study; detailed study of charting operator movements; micromotion study.	
	First Session: 10:20-13:20 (LR and LB combined)	Goldman

IE 443	QUALITY CONTROL	3
	<i>Prerequisite: ST 361</i>	
	First Session: 8:00-10:00 (LR and LB combined)	Prak
IE 591	PROJECT WORK	2-6
	<i>Prerequisite: Graduate or senior standing</i>	
	Second Session: Hours Arranged	Anderson
IE 699	INDUSTRIAL ENGINEERING RESEARCH	Credits Arranged
	Both Sessions: Hours Arranged	Staff

MATHEMATICS

MA 2	REVIEW ALGEBRA	4X
	First Session: 8:00-10:10	Staff
MA 102	ANALYTIC GEOMETRY AND CALCULUS I	4
	<i>Prerequisite: MA 111 or equivalent completed in high school</i>	
	Required of freshmen in the Schools of Engineering and Physical Sciences and Applied Mathematics. The first of three semesters of a unified course in analytic geometry and calculus. Topics include rectangular coordinates in the plane, graphs and equations of lines, algebraic curves, including the conic sections and others examined by general discussion methods. Also introduced are functions, limits, continuity, differentiation of algebraic functions, with applications of derivatives and differentials.	
	Both Sessions: 8:00-10:00, 10:20-12:30	Staff
MA 111	ALGEBRA AND TRIGONOMETRY	4
	Algebraic properties of real numbers; algebra of sets, mappings, functions and graphs. Properties of the complex number field. Applications to systems of equations both linear and quadratic. Other topics in algebra including inequalities, variation, binomial theorem, progressions, theory of equations and determinants. Trigonometric functions of a general angle, identities and multiple angle relations, inverse trigonometric functions, graphs, solution of triangles by logarithms and slide rule with emphasis on the laws of sines and cosines.	
	Both Sessions: 8:00-10:10, 10:20-12:30	Staff
MA 112	ANALYTIC GEOMETRY AND CALCULUS A	4
	<i>Prerequisite: MA 111 or equivalent completed in high school</i>	
	A unified course in analytic geometry and calculus containing the following topics: brief discussion of set operations; the real plane is defined as the set of ordered pairs of $R \times R$ and graphs in two dimensions as subsets of $R \times R$; functions, limits, continuity and definition of a derivative; applications of the derivative; differentiation of trigonometric and inverse trigonometric functions, introduction of antidifferentiation. Applications to the social life and be-	

havioral sciences are included where possible.

First Session: 8:00-10:10, 10:20-12:30

Second Session: 8:00-10:10

Staff

MA 114 TOPICS IN MODERN MATHEMATICS 3

Prerequisite: MA 111 completed in high school

Introduction to the theory of sets, relations and functions with applications to Boolean algebra, logical inference, theory of probability, vector spaces and matrices.

Both Sessions: 8:00-9:30

Staff

MA 115 INTRODUCTION TO CONTEMPORARY MATHEMATICS I 3

Introduction to sets and logic; mathematical induction; evaluation of the number system, elementary Boolean algebra; elementary theory of determinants and matrices; progressions; elementary number theory.

First Session: 8:00-9:30

Staff

MA 116 INTRODUCTION TO CONTEMPORARY MATHEMATICS II 3

Prerequisite: MA 115

Permutations and combinations; elementary probability, graphs; averages; elementary curve fitting; straight line calculus; four-color problem and other historical problems in mathematics.

Second Session: 11:40-13:10

Staff

MA 201 ANALYTIC GEOMETRY AND CALCULUS II 4

Prerequisite: MA 102

The second of three semesters of a unified course in analytic geometry and calculus. Topics include indefinite and definite integrals of algebraic functions and their applications, differentiation of transcendental functions, polar coordinates, parametric equations, curvilinear motion and curvature; formal integration; integration by parts, substitution, and partial fractions.

Both Sessions: 8:00-10:00, 10:20-12:30

Staff

MA 202 ANALYTIC GEOMETRY AND CALCULUS III 4

Prerequisite: MA 201

The third of three semesters of a unified course in analytic geometry and calculus. Topics include areas, volumes, lengths of curves, centroids, moments of inertia of rectangular and polar coordinates; approximate integration, improper integrals, indeterminate forms; infinite series and expansion of functions; solid analytic geometry and partial differentiation, multiple integrals in rectangular, cylindrical and spherical coordinates.

Both Sessions: 8:00-10:10, 10:20-12:30

Staff

MA 212 ANALYTIC GEOMETRY AND CALCULUS B 3

Prerequisite: MA 112

A continuation of MA 112. Additional topics in differentiation; exponential and logarithmic functions, definite integral and applications to areas, and volume; introduction to sequences, series and calculus

of two variables. Applications to social, life, and behavioral sciences are included where possible.

Second Session: 11:40-13:10

Staff

- MA 301** **ELEMENTARY DIFFERENTIAL EQUATIONS I** **3**
Prerequisite: MA 202 or equivalent
First order equations with variables separable; Euler's method of approximate solution; physical and geometrical applications. Linear equations of first order; applications. Linear equations of higher order with constant coefficients; solution by repeated linear first order equations, variation of parameters, undetermined coefficients, operators. Systems of equations; scaling variables, applications to networks and dynamical systems. Introduction to series-solutions; solutions by use of analog computer.
Both Sessions: 8:00-9:30, 11:40-13:10 **Staff**
- MA 401** **INTERMEDIATE DIFFERENTIAL EQUATIONS** **3**
Prerequisite: MA 301
Infinite series and integrals; linear differential equations, special functions.
Both Sessions: 9:50-11:20 **Staff**
- MA 403** **FUNDAMENTAL CONCEPTS OF ALGEBRA** **3**
Prerequisite: MA 202 or MA 212
Integers; integral domains; rational numbers; fields, rings, groups, Boolean algebra.
First Session: 8:00-9:30 **Staff**
- MA 405** **INTRODUCTION TO DETERMINANTS AND MATRICES** **3**
Prerequisite: MA 202 or MA 212
Properties of determinants; theorems of Laplace and Jacobi; systems of linear equations. Elementary operations with matrices; inverse, rank, characteristic roots and eigenvectors. Introduction to algebraic forms.
Both Sessions: 8:00-9:30, 11:40-13:10 **Staff**
- MA 421** **INTRODUCTION TO PROBABILITY** **3**
Prerequisite: MA 301 or consent of department
Definitions, discrete and continuous sample spaces, combinatorial analysis, Stirling's formula, simple occupancy and ordering problems, conditional probability, repeated trials, compound experiments, Bayes' theorem, binomial, Poisson and normal distribution, the probability integral, random variables, expectation.
First Session: 11:40-13:10 **Staff**
- MA 433** **HISTORY OF MATHEMATICS** **3**
Prerequisite: MA 202 or MA 212
Evolution of the number system; trends in the development of modern mathematics; lives and contributions of outstanding mathematicians.
Second Session: 8:00-9:30 **Staff**

- MA 511 ADVANCED CALCULUS I 3**
Prerequisites: MA 301, preferably a B average in mathematics
 Vectors, differential calculus of functions of several variables, vector differential calculus. Definite integral.
 First Session: 8:00-9:30, 11:40-13:10
 Second Session: 9:50-11:20 Staff
- MA 512 ADVANCED CALCULUS II 3**
Prerequisite: MA 511
 Vector integral calculus, infinite series, integral calculus of several variables.
 Both Sessions: 8:00-9:30 Staff
- MA 513 INTRODUCTION TO COMPLEX VARIABLES 3**
Prerequisite: MA 511 or MA 508
 Operations with complex numbers, derivatives, analytic functions, integrals, definitions and properties of elementary functions, multi-valued functions, power series, residue theory and applications, conformal mapping.
 First Session: 12:00-13:30 Staff
- MA 514 METHODS OF APPLIED MATHEMATICS 3**
Prerequisite: MA 511 or MA 508
 Introduction to integral equations, the calculus of variations, and difference equations.
 Second Session: 9:50-11:20 Staff
- MA 524 BOUNDARY VALUE PROBLEMS 3**
Prerequisite: MA 508 or MA 511
 Theory of first variation with applications to various physical phenomena (vibrating string, vibrating membrane, heat conduction and wave propagation); Bernoulli's separation theorem with application to vibration and heat conduction problems; Fourier series, the Sturm-Liouville problem.
 First Session: 11:40-13:10 Staff
- MA 527 NUMERICAL ANALYSIS I 3**
Prerequisite: MA 508 or MA 511
 Numerical solution of equations, introduction to the theory of errors, finite-difference tables and the theory of interpolation, numerical integration, numerical differentiation, and elements of difference calculus.
 Second Session: 8:00-9:30 Staff
- MA 532 THEORY OF ORDINARY DIFFERENTIAL EQUATIONS 3**
Prerequisite: MA 511 or MA 508
 First order equations, linear n^{th} order equations with constant coefficients and with continuous coefficients, Green's functions, solution of linear equations with analytic coefficients, second order linear equations with regular singular points, systems of first order equations, uniqueness theorems, existence theorems of Picard and Peano,

stability of solutions of linear plane autonomous systems, numerical solutions.

Special 8½ weeks session (June 10-August 8): 10:20-11:20 Staff

MA 541 (ST 541) THEORY OF PROBABILITY I 3
Prerequisite: MA 508 or MA 511

Axioms, discrete and continuous sample spaces, events, combinatorial analysis, conditional probability, repeated trials, independence, random variables, expectation, special discrete and continuous distributions, probability and moment generating functions, central limit theorem, laws of large numbers, branching processes, recurrent events, random walk.

Special 8½ weeks session (June 10-August 8): 12:00-13:00 Staff

MA 622 LINEAR ALGEBRA 3
Prerequisite: MA 405 or equivalent

A study of vector spaces and their relation to the theory of matrices, the characteristic and minimal polynomials of a matrix, functions of matrices, theory of elementary divisors, canonical forms of a matrix, application to systems of differential equations.

Special 8½ weeks session (June 10-August 8): 8:00-9:00 Staff

MA 632 OPERATIONAL MATHEMATICS I 3
Prerequisite: MA 513 or MA 611

Laplace transform with theory and application to ordinary and partial differential equations arising from problems in engineering and physics.

Special 8½ weeks session (June 10-August 8): 9:10-10:10 Staff

MA 699 RESEARCH IN MATHEMATICS Credits Arranged
Prerequisites: Graduate standing, consent of advisor
Individual research in the field of mathematics.
Both Sessions: Hours Arranged

MECHANICAL AND AEROSPACE ENGINEERING

MAE 211 INTRODUCTION TO MECHANICAL ENGINEERING 3
Prerequisite: CH 103

Corequisites: MA 202, PY 208

An elementary consideration of some of the scope and interests in mechanical engineering through the application and extension of the basic laws of chemistry and physics.

First Session: 9:50-11:20, 11:40-13:00 Staff

MAE 212 MECHANICAL ANALYSIS 3
Prerequisite: MAE 211
Corequisite: EM 200

An introduction to a logical method of problem solving through the integration of the fundamentals of physics, mechanics, and mathematics and their utilization of a rigorous training in methods of analysis of real engineering problems.

Second Session: 9:50-11:20, 11:40-13:00 Staff

- MAE 301 ENGINEERING THERMODYNAMICS I** **3**
Prerequisites: MA 202, PY 208
 Probability, uncertainty, information and entropy; the perfect gas; energy levels and quantum states; Maxwell-Boltzmann distribution of energies and speeds; principle of increase of entropy; conservation of energy, thermodynamic properties of systems; applications to the closed and open systems; fundamentals of energy conversion and refrigeration.
 First Session: 7:30-9:00, 8:00-9:30, 9:50-11:20 Staff
- MAE 302 ENGINEERING THERMODYNAMICS II** **3**
Prerequisite: MAE 301
 A continuation of Engineering Thermodynamics I with the emphasis on the engineering application of the basic principles to problems involving mixtures of perfect gases, psychometrics, imperfect gases, equations of state, chemical reactions, combustion, law of mass action, dissociation and ionization, and equilibrium composition.
 Second Session: 8:00-9:30 Staff
- MAE 303 ENGINEERING THERMODYNAMICS III** **3**
Prerequisite: MAE 301
 A continuation of Engineering Thermodynamics I for nonmechanical engineering juniors. Thermodynamics of mixtures; thermodynamics of fluid flow, heat transfer, vapor and gas cycles, and applications.
 Second Session: 9:50-11:20, 11:40-13:10 Staff
- MAE 305 MECHANICAL ENGINEERING LABORATORY I** **1**
Corequisite: MAE 301
 Theory and principles involved in instrumentation and measurements. Limitation and sources of error of each technique studied.
 First Session: 13:40-17:50 TTh Staff
- MAE 306 MECHANICAL ENGINEERING LABORATORY II** **1**
Prerequisites: MAE 305, EM 301
 A continuation of MAE 305 with emphasis on measurements of kinematic quantities, measurements of thermophysical properties and energy measurements. Treatment of experimental data.
 Second Session: 13:40-17:50 TTh Staff
- MAE 315 DYNAMICS OF MACHINES** **3**
Prerequisite: MAE 212
 A rational application of dynamics to the analysis of machines and mechanical devices to determine the motions resulting from applied loads and the forces and inputs required to produce specified motions.
 First Session: 9:50-11:20 Staff
- MAE 352 AERODYNAMICS** **3**
Prerequisites: EM 200, MA 301
 Fundamental concepts underlying experimental aerodynamics, the aerodynamicist's data, elementary flow theory, Reynolds number and

the effect of viscosity, Mach number and compressibility, finite wing theory.

First Session: 8:00-9:30

Staff

MAE 353	INTRODUCTION TO AEROTHERMODYNAMICS	3	
	<i>Prerequisites: MAE 301, C or better in MAE 352</i>		
	A specialization of thermodynamics to the study of inviscid compressible flows of perfect gases. The theory is applied to channel flows, shock waves, expansions, and two-dimensional airfoil theory.		
	Second Session: 7:30-9:00		Staff
MAE 402	HEAT AND MASS TRANSFER	3	
	<i>Prerequisites: MAE 302, MA 301</i>		
	First Session: 8:00-9:30		Staff
MAE 412	MECHANICAL DESIGN II	3	
	<i>Prerequisites: EM 301, MIM 201, MAE 315</i>		
	First Session: 8:00-9:30		Staff
MAE 435	PRINCIPLES OF AUTOMATIC CONTROL	3	
	<i>Prerequisite: MAE 301</i>		
	First Session: Hours Arranged		Staff
MAE 447	PERFORMANCE, STABILITY AND CONTROL OF FLIGHT VEHICLES	3	
	<i>Prerequisites: MA 401 or MA 511, C or better in MAE 352</i>		
	First Session: 11:40-13:00		Staff
MAE 461	AEROSPACE TECHNOLOGY	3	
	<i>Prerequisite: MAE 353</i>		
	First Session: 9:50-11:20		Williams
MAE 521	AEROTHERMODYNAMICS	3	
	<i>Prerequisites: MAE 301, MAE 352, or EM 303</i>		
	First Session: 9:50-11:20		Perkins
MAE 545	PROJECT WORK IN MECHANICAL ENGINEERING I	2	
	First Session: Hours Arranged		Staff
MAE 550	CRYOGENICS	3	
	First Session: Hours Arranged		Staff
MAE 571	INERTIAL GUIDANCE, DESIGN AND ANALYSIS	3	
	First Session: Hours Arranged		Staff
MAE 653	SUPERSONIC AERODYNAMICS	3	
	<i>Prerequisite: MAE 652</i>		
	Second Session: 9:50-11:20		Pinkerton

MAE 658	MOLECULAR GAS DYNAMICS	3
	First Session: 8:00-9:30	Williams
MAE 699	MECHANICAL ENGINEERING RESEARCH	Credits Arranged
	<i>Prerequisites: Graduate standing in mechanical engineering, consent of advisor</i>	
	Both Sessions: Hours Arranged	Staff

METALLURGICAL ENGINEERING

MIM 201	STRUCTURE AND PROPERTIES OF ENGINEERING MATERIALS I	3
	<i>Prerequisite: CH 103</i>	
	An introduction to the fundamental physical principles governing the structure and constitution of metallic and nonmetallic materials of construction, and the relation of these principles to the control of properties.	
	Both Sessions: LR 12:00-13:00; LB 13:00-16:00 MWF	Waller
MIM 202	STRUCTURE AND PROPERTIES OF ENGINEERING MATERIALS II	3
	<i>Prerequisite: CH 103</i>	
	Second Session: LR 12:00-13:00; LB 13:00-16:00 MWF	Staff
MIM 331	PHYSICAL METALLURGY I	3
	<i>Prerequisites: CH 103, MIM 201</i>	
	The fundamental principles of physical metallurgy with emphasis on correlation between structure, constitution, and properties of metals and alloys. A systematic development of the metallurgical aspects of atomic and crystalline structure, phase equilibrium, solid solution, diffusion, precipitation hardening, elastic and plastic behavior, and recrystallization.	
	First Session: Hours Arranged	Waller
MIM 332	PHYSICAL METALLURGY II	3
	<i>Prerequisite: MIM 331</i>	
	Second Session: Hours Arranged	Waller
MIM 401	METALLURGICAL OPERATIONS I (For Engineering Operations students only)	4
	<i>Prerequisite: MIM 332</i>	
	A systematized treatment of the fundamental operations involved in the production and fabrication of metals and alloys. Deals primarily with procedures and operations employed in chemical or extractive metallurgy. Special emphasis placed on principles applicable to courses required by students engaged in materials minor sequence without physical chemistry background.	
	First Session: LR 9:50-11:20; LB 13:00-16:00 MWF	Magor
MIM 402	METALLURGICAL OPERATIONS II (For Engineering Operations students only)	4
	<i>Prerequisite: MIM 332</i>	

Covers the operation of physical and mechanical metallurgy. Special emphasis placed on principles applicable to courses required by students engaged in materials minor sequence without physical chemistry background.

First Session: LR 9:50-11:20; LB 13:00-16:00 MWF

Staff

- MIM 495** **EXPERIMENTAL ENGINEERING I** **3**
Prerequisite: MIM 422 or consent of instructor
 Advanced engineering principles applied to a specific project dealing with metallurgy, metallography or general experimental work. A seminar period is provided and a written report required.
 First Session: Hours Arranged **Staff**
- MIM 496** **EXPERIMENTAL ENGINEERING II** **3**
Prerequisite: MIM 422 or consent of instructor
 Second Session: Hours Arranged **Staff**
- MIM 595** **ADVANCED METALLURGICAL EXPERIMENTS I** **3**
Prerequisite: MIM 422 or consent of instructor
 Advanced engineering principles applied to a specific experimental project dealing with metallurgy, metallography. A seminar period is provided and a written report is required.
 First Session: Hours Arranged **Staff**
- MIM 596** **ADVANCED METALLURGICAL EXPERIMENTS II** **3**
Prerequisite: MIM 422 or consent of instructor
 Second Session: Hours Arranged **Staff**
- MIM 699** **METALLURGICAL ENGINEERING RESEARCH** **Credits Arranged**
 Independent investigation of an appropriate problem in metallurgical engineering. A report on this investigation is required as a graduate thesis.
 Both Sessions: Hours Arranged **Staff**

MICROBIOLOGY

- MB 301** **MICROBIAL LIFE** **3**
 Introduction to the basic concepts of microbiology and how they affect our daily lives. Primarily for nonbiologists.
 First Session: 9:50-11:20 MTThF **Staff**
- MB 302** **CLINICAL MICROBIOLOGY LAB** **1**
Corequisite: MB 301
 Techniques of isolating and characterizing microorganisms of medical significance. For student nurses and other paramedical students.
 First Session: 13:40-16:50 TTh **Staff**
- MB 692** **SPECIAL PROBLEMS IN MICROBIOLOGY** **Credits Arranged**
 Both Sessions: Hours Arranged **Staff**

MODERN LANGUAGES

FRENCH

- MLF 101 ELEMENTARY FRENCH I 3**
Structure, diction, pronunciation and other matters of technique of the language, supplemented by readings and translations. No previous training in the language necessary.
First Session: 8:00-9:30, 9:50-11:20
Second Session: 8:00-9:30 Staff
- MLF 102 ELEMENTARY FRENCH II 3**
Prerequisite: MLF 101 or equivalent
A survey of the basic elements of grammar accompanied and illustrated by intermediate readings progressing to the reading of standard texts.
First Session: 9:50-11:20
Second Session: 8:00-9:30, 9:50-11:20 Staff
- MLF 201 FRENCH CIVILIZATION 3**
Prerequisites: MLF 102 or equivalent
Special emphasis given to translating from French. After a preliminary survey of the land and people of France, such topics as language, arts, science, literature, philosophy, etc. are given consideration. Parallel readings and reports.
First Session: 8:00-9:30 Staff
- MLF 202 FRENCH PROSE—SELECTIONS FROM MODERN FRENCH LITERATURE 3**
Prerequisites: MLF 102 or equivalent
Selected readings from literary French. Attention given to the attainment of skill in reading and comprehension.
Second Session: 8:00-9:30 Staff
- MLF 203 REVIEW GRAMMAR AND COMPOSITION 3**
Prerequisite: MLF 102 or equivalent
This course will bridge the gap between basic grammar courses and the more advanced literary courses preparing the student for the type of composition and conversation expected of him in the latter. It will also offer an opportunity for students with previous knowledge of a language from secondary schools to review grammar and obtain experience in an area not normally covered in their high school work.
First Session: 9:50-11:20 Staff
- MLF 401 FRENCH GRAMMAR FOR GRADUATE STUDENTS 3**
This course is designed to present the grammar of scientific French as rapidly as possible in preparation for the reading course which follows.
First Session: 8:00-9:30, 9:50-11:20 Ballenger, Staff

- MLF 402 SCIENTIFIC FRENCH 3**
Prerequisite: MLF 401 or equivalent
 Reading and translation of technical French, supplemented by discussions on terminology, word order, vocabulary analysis and other linguistic techniques. Subject material adjusted to individual needs; conferences.
 Both Sessions: Hours Arranged Staff
- GERMAN**
- MLG 101 ELEMENTARY GERMAN I 3**
 Study of the structure and technique of the language, supplemented by easy reading and translations. No previous training in the language necessary.
 First Session: 8:00-9:30, 9:50-11:20 Staff
- MLG 102 ELEMENTARY GERMAN II 3**
Prerequisite: MLG 101 or equivalent
 A course designed primarily for students who wish to attain proficiency in reading German. Attention given to basic grammar and vocabulary with practice in the translation and interpretation of German prose.
 Both Sessions: 8:00-9:30 Staff
- MLG 201 GERMAN PROSE: SELECTIONS FROM MODERN GERMAN LITERATURE 3**
Prerequisite: MLG 102 or equivalent
 Readings in German literature, a study of representative authors and their contribution to the development of the German language and culture. Parallel readings and reports.
 First Session: 9:50-11:20 Staff
- MLG 202 GERMAN CIVILIZATION 3**
Prerequisite: MLG 102 or equivalent
 Readings in the history and customs of Germany, supplemented by lectures on such topics as language, arts, science, philosophy, etc. Parallel readings and reports.
 Second Session: 9:50-11:20 Staff
- MLG 401 GERMAN GRAMMAR FOR GRADUATE STUDENTS 3**
 This course is open to graduate students and senior honor students and is designed to present the grammar of scientific German as rapidly as possible in preparation for the reading course which follows.
 First Session: 8:00-9:30, 9:50-11:20
 Second Session: 8:00-9:30 Staff
- MLG 402 SCIENTIFIC GERMAN 3**
Prerequisite: MLG 401 or equivalent
 Reading and translation of technical German, supplemented by discussions on terminology, word order, vocabulary analysis and other linguistic techniques. Subject material adjusted to individual needs;

conferences.

First Session: 8:00-9:30, 9:50-11:20

Hall

Second Session: 9:50-11:20

Howard, Staff

SPANISH

- MLS 101** **ELEMENTARY SPANISH I** **3**
Structure, diction, pronunciation and other matters of technique of the language, supplemented by easy readings. No previous training in the language necessary.
First Session: 8:00-9:30, 9:50-11:20 **Staff**
- MLS 102** **ELEMENTARY SPANISH II** **3**
Prerequisite: MLS 101 or equivalent
A survey of the basic elements of grammar accompanied and illustrated by intermediate readings progressing to the reading of standard texts.
Second Session: 8:00-9:30, 9:50-11:20 **Staff**
- MLS 201** **SPANISH CIVILIZATION** **3**
Prerequisite: MLS 102 or equivalent
Emphasis is placed upon translating Spanish prose and developing vocabulary. The readings give the student a comprehensive picture of the culture, geography, history and economy of Spain.
First Session: 9:50-11:20 **Staff**
- MLS 202** **HISPANO-AMERICAN CIVILIZATION** **3**
Prerequisite: MLS 102 or equivalent
Comprehensive picture of the culture, geography, history and economy of the Spanish American countries.
Second Session: 8:00-9:30 **Staff**
- MLS 401** **SPANISH GRAMMAR FOR GRADUATE STUDENTS** **3**
The course is designed to present the grammar of scientific Spanish as rapidly as possible in preparation for the reading course which follows.
First Session: 9:50-11:20 **Staff**
- MLS 402** **SCIENTIFIC SPANISH** **3**
Prerequisite: MLS 401 or equivalent
Reading and translation of technical Spanish, supplemented by discussion on terminology, word order, vocabulary analysis and other linguistic techniques. Subject material adjusted to individual needs; conferences.
Second Session: Hours Arranged **Staff**

MUSIC

- MUS 200** **MUSIC IN OUR CONTEMPORARY LIFE** **3**
A course especially designed to assist students in developing their understanding of music as a vital part in today's life. Special em-

phasis on evaluating musical form and content, style periods, design and interpreting music as it relates to various aspects of today's society.

First Session: 8:00-9:30, 9:50-11:20

Adcock, Dellinger

Second Session: 8:00-9:30

Bliss

MUS 210 A SURVEY OF MUSIC IN AMERICA 3

A survey of the music in the United States from colonial times to the present, with particular emphasis on the major influences which have shaped the musical literature and culture of America.

First Session: 8:00-9:30, 9:50-11:20

Adcock, Dellinger

MUS 220 MUSIC OF THE ROMANTIC PERIOD 3

A course designed to provide an insight into the significant musical forms of the Romantic Period. Subject matter will include an analysis of the music literature of the prevailing forms, the styles of the composers and the relation of music to other romantic art forms.

Second Session: 9:50-11:20

Bliss

NUCLEAR ENGINEERING

NE 518 RADIOLOGICAL SAFETY 3

Prerequisite: PY 410, NE 530

Treatment of types of radiation and their interaction with matter, shielding and biological effects. Study of safety considerations in a nuclear installation, including regulations, instrumentation used, overall detection systems, emergency situations and radiation containment.

Special 11 weeks session (June 5-August 22): Hours Arranged

Elleman

NE 530 INTRODUCTION TO NUCLEAR REACTOR THEORY 3

Prerequisite: PY 410

The principles of neutron motion in matter, with emphasis on the analysis of the nuclear chain reactor. Slowing of neutrons, diffusion, space distributions of flux, conditions for criticality, group theories, and the time-dependent behavior of fissionable assemblies.

Special 11 weeks session (June 5-August 22): Hours Arranged

Carnesale

NE 591 SPECIAL TOPICS IN NUCLEAR ENGINEERING I 3

Prerequisite: Consent of instructor

This course will be used to explore unusual and/or specialized areas of nuclear engineering.

First Session: Hours Arranged

Staff

NE 691 ADVANCED TOPICS IN NUCLEAR ENGINEERING I 3

Prerequisite: Consent of instructor

A study of recent developments in nuclear engineering theory and practice.

First Session: Hours Arranged

Staff

- NE 695 SEMINAR IN NUCLEAR ENGINEERING 1
 Discussion of selected topics in nuclear engineering.
 First Session: Hours Arranged Staff
- NE 699 RESEARCH IN NUCLEAR ENGINEERING Credits Arranged
Prerequisite: Graduate standing
 Individual research in the field of nuclear engineering.
 Both Sessions: Hours Arranged Staff

OPERATIONS RESEARCH

- OR 501 INTRODUCTION TO OPERATIONS RESEARCH 3
Prerequisites: MA 405, MA 421, enrolled for operations research minor
 An introduction to the literature and methodology of operations research and its application in the areas of production and logistics control, queues, replacement, allocation and competitive systems.
 Special eight weeks session (June 12-August 4): 9:50-11:20 TTh
 Elmaghraby

PHILOSOPHY

(Also see Religion, page 75.)

- PHI 201 LOGIC 3
 A basic course covering the nature and evaluation of logical discourse, both deductive and inductive.
 First Session: 8:00-9:30 Metzger
- PHI 205 PROBLEMS AND TYPES OF PHILOSOPHY 3
 An introduction to the nature and function of philosophy; a study of problems in such areas of philosophy as ethics, politics, theory of knowledge, metaphysics.
 First Session: 8:00-9:30, 9:50-11:20
 Second Session: 9:50-11:20, 11:40-13:10
 Bredenberg, Bryan, Regan
- PHI 304 (ED 304) PHILOSOPHY OF EDUCATION 3
 A survey of the contemporary scene and projected trends relative to the philosophy of education including a review of the impact on education of selected historical forces such as idealism, realism, essentialism, permissivism, progressivism and perennialism. An analysis of the meaning and aims of education as reflected in the educational concepts of Dewey, James, Hutchins and others.
 Second Session: 8:00-9:30 Middleton
- PHI 305 PHILOSOPHY OF RELIGION 3
 Philosophical inquiry into the nature and function of religion; consideration of the meaning of central concepts of the Western religious tradition.
 Second Session: 8:00-9:30 Fitzgerald

- PHI 306 PHILOSOPHY OF ART 3**
 Study of historical and contemporary theories of art; development of a coherent set of concepts for analysis and discussion of esthetic experience, critical judgments, works of art and their relations to other aspects of culture.
 First Session: 8:00-9:30 **Bredenberg**
- PHI 307 ETHICS 3**
 Study of major ethical theories; systematic analysis of the nature of value judgments, and the concepts of moral obligation, right and good; personal and social aspects of human conduct.
 First Session: 9:50-11:20 **Regan**
- PHI 310 EXISTENTIALISM 3**
 An examination of one of the major movements of twentieth century philosophy. The course will consider the nineteenth century background of existentialism, including the work of Kierkegaard and Nietzsche, as well as such prominent twentieth century existentialists as Sartre and Jaspers.
 Second Session: 9:50-11:20 **Fitzgerald**
- PHI 405 FOUNDATIONS OF SCIENCE 3**
 Nature and validity of knowledge, basic concepts of modern science, scientific method and the implications of the philosophy of modern science for ethics, social philosophy and the nature of reality.
 First Session: 9:50-11:20 **Metzger**

PHYSICAL EDUCATION

- PE 112 BEGINNING SWIMMING I 1**
 A course for nonswimmers which is designed for meeting the University swimming requirements and for preparing the student to take Beginning Swimming II.
 Both Sessions: 12:00-13:00 **Boettner, Daniels**
- PE 221 INTERMEDIATE SWIMMING 1**
 A course designed to give the student competence in four basic strokes and two dives.
 Both Sessions: 12:00-13:00, 13:00-14:00 **Boettner, Daniels, Keating**
- PE 241 ANGLING 1**
 A course designed to teach the fundamental skills of spin, fly and bait casting and an understanding of game fishing.
 Both Sessions: 12:00-13:00 **Smith, Keating**
- PE 245 GOLF 1**
 A course designed for teaching beginners the grip, stance, swing and use of the various clubs, along with the history and etiquette of play.
 Both Sessions: 8:00-9:00, 10:20-11:20, 12:00-13:00, 13:40-14:40
Smaltz, Sonner, Isenhour

PE 249	TENNIS I	1
	A course designed to give beginners a thorough knowledge of the history, rules and strategy, as well as the fundamental skills, of tennis.	
	Both Sessions: 9:10-10:10, 10:20-11:20, 13:40-14:40	
	Rhodes, Isenhour, Keating	
PE 251	ARCHERY	1
	A course designed to teach the fundamental skills of target archery and the selection and care of archery equipment.	
	Both Sessions: 9:10-10:10, 12:00-13:00, 13:40-14:00	
	Weaver, Daniels, Isenhour	
PE 265	SOFTBALL	1
	A course designed to include the fundamental skills, history and rules of the game.	
	First Session: 12:00-13:00	Rhodes
	Second Session: 10:20-11:20	Daniels
PE 269	VOLLEYBALL	1
	A course designed to include the fundamental skills, history, rules and strategy of the game.	
	First Session: 10:20-11:20	Weaver

PHYSICS

PY 205	GENERAL PHYSICS	4
	<i>Corequisite: MA 201</i>	
	Mechanics, Heat and Sound	
	Both Sessions: LR 8:00-9:30, 9:50-11:20; LB 12:50-15:00, 15:10-17:20 MW or TTh	
	Staff	
PY 206	GENERAL PHYSICS	4
	<i>Prerequisite: PY 205</i>	
	Electricity and Magnetism, Light	
	First Session: LR 9:50-11:20; LB 12:50-15:00 MW	Staff
PY 207	GENERAL PHYSICS	4
	<i>Prerequisite: PY 206</i>	
	Light and Modern Physics	
	Both Sessions: LR 8:00-9:30; LB 12:50-15:00 TTh	Staff
PY 208	GENERAL PHYSICS	5
	<i>Prerequisite: PY 205</i>	
	Electricity, Light and Modern Physics	
	Both Sessions: LR 7:30-9:40, 9:50-12:00; LB 12:50-15:00, 15:10-17:20 MW or TTh	
	Staff	

PY 211	GENERAL PHYSICS	4
	<i>Prerequisite: MA 111 or MA 116</i>	
	Mechanics, Heat and Sound	
	Both Sessions: LR 8:00-9:30, 9:50-11:20; LB 12:50-15:00, 15:10-17:20 MW or TTh	Staff
PY 212	GENERAL PHYSICS	4
	<i>Prerequisite: PY 211</i>	
	Light and Electricity	
	Both Sessions: LR 8:00-9:30, 9:50-11:20; LB 12:50-15:00, 15:10-17:20 MW or TTh	Staff
PY 221	COLLEGE PHYSICS	5
	<i>Prerequisite: MA 111</i>	
	An introduction to the origins of physical science, the fundamental principles of physics and the many applications to modern technology. Lectures and demonstrations with class participation.	
	Both Sessions: 7:30-10:10	Staff
PY 407	INTRODUCTION TO MODERN PHYSICS	3
	<i>Prerequisites: PY 208, MA 202</i>	
	A survey of the important developments in atomic and nuclear physics of this century.	
	Both Sessions: 8:00-9:30	Staff
PY 410	NUCLEAR PHYSICS I	4
	<i>Prerequisite: PY 207 or PY 407</i>	
	An introduction to the properties of the nucleus and the interaction of radiation with matter.	
	First Session: LR 9:50-11:20; LB 13:40-15:50 TTh	Waltner
PY 501	INTRODUCTION TO QUANTUM MECHANICS I	3
	<i>Prerequisites: MA 511; PY 411 or PY 414</i>	
	An introduction to the foundations of quantum and wave mechanics, with solutions of the problems of the free particle, harmonic oscillator, rigid rotating molecule and the hydrogen atom.	
	First Session: 9:50-11:20	Cobb
PY 510	NUCLEAR PHYSICS II	4
	<i>Prerequisite: PY 410</i>	
	The description and analysis of nuclear energy levels, meson theory, nuclear resonance, atomic and molecular magnetism, and cosmic radiation. Principles and experiments in neutron physics are discussed.	
	First Session: LR 7:30-9:00; LB Hours Arranged	Waltner
PY 695	SEMINAR	1
	Both Sessions: 13:00-14:30 MW	Staff
PY 699	RESEARCH	Credits Arranged
	Both Sessions: Hours Arranged	Staff

PLANT PATHOLOGY

- PP 503** **DIAGNOSIS OF PLANT DISEASES** **3**
Prerequisites: One advanced course in plant pathology, consent of instructor
 A study of techniques used in plant disease diagnosis with emphasis on diagnostic value of signs and symptoms for certain types of disease. Consideration will be given to major sources of descriptive information on plant pathogens and the use of keys for the identification of fungi.
 First Session: Hours Arranged **Hodges**
- PP 699** **RESEARCH IN PLANT PATHOLOGY** **Credits Arranged**
Prerequisites: Graduate standing, consent of instructor
 Original research in plant pathology.
 Both Sessions: Hours Arranged **Staff**

POLITICS

- PS 201** **THE AMERICAN GOVERNMENTAL SYSTEM** **3**
 A study of the American federal system, with emphasis on constitutional principles, major governmental organs, governmental functions, and the politics and machinery of elections.
 Both Sessions: 7:30-9:00, 11:40-13:10 **Instructors from Chapel Hill**
- PS 301** **MODERN POLITICAL SYSTEMS: EUROPE** **3**
 A comparative analysis of the structure and processes of politics in the United Kingdom, France and Germany.
 First Session: 11:40-13:10 **Scism**
- PS 321** **U. S. FOREIGN POLICY** **3**
Prerequisites: PS 201, HI 112
 This course examines the determinants of American foreign policy and the economic, military, strategic and psychological factors conditioning that policy. Emphasis is placed on the formulation of policy, including the roles of the Executive, Congress, and the public opinion, and on problems of content and execution.
 Second Session: 11:40-13:10 **Gilbert**
- PS 322** **CONTEMPORARY WORLD POLITICS** **3**
 A study of the pattern of international life, the instruments of national policy, the controls upon international behavior and the major problems in international relations since World War II.
 First Session: 8:00-9:30
- PS 401** **AMERICAN PARTIES AND PRESSURE GROUPS** **3**
 After a brief survey of those features of American government essential to an understanding of the political process, the course

proceeds to examine the American electorate and public opinion and devotes its major attention to the nature, organization and programs of pressure groups and political parties and to their efforts to direct opinion, gain control of government and shape public policy.
 Second Session: 7:30-9:00 Staff

- PS 442** **GOVERNMENT AND PLANNING** **3**
Prerequisite: PS 201 or consent of department
 A study of the planning function at all levels of government in the United States, with particular attention to the problems posed for planning by the rapid growth of metropolitan areas.
 Second Session: 7:30-9:00 Graduate Staff
- PS 510** **(EC 510) PUBLIC FINANCE** **3**
Prerequisite: EC 205
 A survey of the theories and practices of governmental taxing, spending and borrowing, including intergovernmental relationships and administrative practices and problems.
 Second Session: 9:50-11:20 Graduate Staff
- PS 521** **PROBLEMS IN URBAN AND METROPOLITAN AREA GOVERNMENT** **3**
Prerequisite: PS 202 or consent of instructor
 This course examines theory and research on problems affecting governments in metropolitan areas. Principal attention is given to those problems which affect (or result from) governmental structure, institutions, and politics and to the alternative approaches to their solutions.
 First Session: 7:30-9:00 Graduate Staff
- PS 696** **SEMINAR IN POLITICS** **2-4**
Prerequisite: Advanced graduate standing
 An independent advanced research course in selected problems of government and politics. The problems will be chosen in accordance with the needs and desires of the students registered for the course.
 First Session: 9:50-11:20 Graduate Staff

POULTRY SCIENCE

- PO 201** **POULTRY PRODUCTION** **4**
 A general introductory course in the principles and practices of broiler, market egg, hatching egg and turkey production.
 First Session: LR 9:50-11:20; LB 13:40-16:20 TTh Brown
- PO 698** **SPECIAL PROBLEMS IN POULTRY SCIENCE** **Maximum 6**
Prerequisite: Graduate standing
 Both Sessions: Hours Arranged **Staff**
- PO 699** **POULTRY RESEARCH** **Credits Arranged**
Prerequisite: Graduate standing
 Both Sessions: Hours Arranged **Staff**

PSYCHOLOGY

- PSY 200 INTRODUCTION TO PSYCHOLOGY 3**
 A study of the general characteristics of human behavior, including motivation, learning, development, emotion, thinking, perception, sensation and measurement.
 Both Sessions: 8:00-9:30, 9:50-11:20, 11:40-13:10 Staff
- PSY 210 PSYCHOLOGICAL ANALYSIS APPLIED TO CURRENT PROBLEMS 3**
Prerequisite: PSY 200
 The development of skills in the analysis and understanding of selected current problems through the use of psychological knowledge and techniques.
 First Session: 11:40-13:10 Miller, Cook
- PSY 300 SENSATION AND PERCEPTION 3**
Prerequisites: PSY 200, sophomore standing; introductory physics or chemistry recommended
 An extensive survey of the determiners of perception. The roles of learning and motivation as determiners of perception are emphasized.
 First Session: 9:50-11:20 LeVere
- PSY 302 PSYCHOLOGY OF PERSONALITY AND ADJUSTMENT 3**
Prerequisite: PSY 200
 A study of the factors involved in the development of the normal personality.
 First Session: 8:00-9:30 Corter
- PSY 304 EDUCATIONAL PSYCHOLOGY 3**
Prerequisite: PSY 200
 A study of learning and evaluation in the context of educational practice.
 First Session: 8:00-9:30 Cole
 Second Session: 9:50-11:20
- PSY 337 INDUSTRIAL PSYCHOLOGY I 3**
Prerequisite: PSY 200
 The application of psychological principles to the problems of industry and business.
 Second Session: 9:50-11:20 Pearson
- PSY 476 PSYCHOLOGY OF ADOLESCENCE 2**
Prerequisite: PSY 200
 Nature and source of the problems of adolescents in western culture.
 First Session: 10:20-11:20 Seidel
- PSY 491, 492 SEMINAR IN PSYCHOLOGY 3**
Prerequisites: Senior standing, consent of department
 Course designed to provide the undergraduate psychology major with skill in designing and conducting independent research.
 Both Sessions: Hours Arranged Newman

- PSY 504 **ADVANCED EDUCATIONAL PSYCHOLOGY** **3**
Prerequisites: Six hours psychology
 A critical appraisal of current psychological findings that are relevant to educational practice and theory.
 Second Session: 8:00-9:30 Johnson
- PSY 535 **TESTS AND MEASUREMENTS** **3**
Prerequisites: Six hours psychology
 An introduction to the theory of psychological measurement.
 First Session: 9:50-11:20 Westbrook
- PSY 576 **DEVELOPMENTAL PSYCHOLOGY** **3**
Prerequisites: Nine hours psychology including PSY 475 or PSY 476
 A survey of the role of growth and development in human behavior, particularly of the childhood and adolescent periods.
 First Session: 13:40-15:10 Seidel
- PSY 690 **SEMINAR IN INDUSTRIAL PSYCHOLOGY** **3**
 Scientific articles, analysis of experimental designs in industrial psychology, and special problems of interest to graduate students in industrial psychology.
 Both Sessions: Hours Arranged Miller
- PSY 691 **SPECIAL TOPICS IN PSYCHOLOGY** **1-3**
Prerequisites: Graduate standing, consent of instructor
 Course will provide opportunity for exploration in depth of advanced topical areas.
 First Session: Hours Arranged Staff
- PSY 693 **PSYCHOLOGICAL CLINIC PRACTICUM** **Maximum 12**
Prerequisite: Nine hours psychology
 Clinical participation in interviewing, counseling, psychotherapy and administration of psychological tests.
 Both Sessions: Hours Arranged Corter
- PSY 699 **RESEARCH IN PSYCHOLOGY** **Credits Arranged**
Prerequisites: Graduate standing, consent of instructor
 Both Sessions: Hours Arranged

RECREATION RESOURCES ADMINISTRATION

- RRA 152 **INTRODUCTION TO RECREATION** **3**
 This course is designed to provide instruction in the areas of history and foundations of recreation including objectives, economic, and social aspects, definition and importance; status of organized recreation in our modern society; certain applied principles of recreation; recreational leadership; activities and program planning; and tournament planning and administration. This course is of lecture-laboratory technique.
 Both Sessions: 8:00-9:30 Staff

- RRA 253 PRINCIPLES OF PHYSICAL EDUCATION 3**
 This course is designed to give the student a professional orientation in physical education and the place of physical education activities in allied and related fields.
 Both Sessions: 9:50-11:20 **Staff**
- RRA 475 RECREATION AND PARK INTERNSHIP 9**
Prerequisite: Senior standing and RRA 359
 Special nine weeks session: Hours Arranged **Miller, Sternloff**

RELIGION

(Also see Philosophy, page 67.)

- REL 300 INTRODUCTION TO RELIGION 3**
 Analysis of the nature and significance of religious phenomena, especially in relation to the culture in which we find ourselves.
 Second Session: 9:50-11:20 **Middleton**
- REL 403 RELIGIONS OF THE WORLD 3**
 Background, general characteristics and basic teachings of the major living religions of the world; consideration of contemporary secular movements that are in a sense religions.
 First Session: 8:00-9:30, 9:50-11:20 **Highfill**

SOCIAL STUDIES

- SS 301 SCIENCE AND CIVILIZATION 3**
Prerequisites: Consent of department (for engineering students: ENG 205, HI 105, EC 205)
 Elective for others
 An examination of the major concepts, methods and values that characterize modern thought in the fields of physical science, the humanities and the social sciences. The course utilizes the student's previous training, plus materials from the history and philosophy of science and the history of technology to demonstrate the essential interrelatedness of scientific, social and aesthetic activity.
 Both Sessions: 8:00-9:30, 9:50-11:20 **Staff**
- SS 302 SCIENCE AND CIVILIZATION 3**
Prerequisite: SS 301
 See description for SS 301.
 Both Sessions: 8:00-9:30, 9:50-11:20 **Staff**
- SS 491 CONTEMPORARY ISSUES 3**
Prerequisites: Consent of department (for engineering students: SS 301, SS 302)
 Elective for others

This course deals with concrete problems as they arise from day to day in the world of public affairs. These problems are studied and discussed in the context of a search for a more realistic definition of the limits of freedom and authority. Text materials are books, magazines and newspapers.

Both Sessions: 8:00-9:30, 9:50-11:30

Staff

SS 492 CONTEMPORARY ISSUES

3

Prerequisites: Consent of department (for engineering students: SS 301, SS 302)

Elective for others

See description of SS 491.

Both Sessions: 8:00-9:30, 9:50-11:20

Staff

SOCIOLOGY

(Also see Anthropology, page 23.)

SOC 202 PRINCIPLES OF SOCIOLOGY

3

Introduction to the scientific study of man's behavior in relation to other men, the general laws affecting the organization of such relationships and the effects of social life on human personality and behavior.

Both Sessions: 8:00-9:30, 9:50-11:20, 11:40-13:10

Staff

SOC 301 HUMAN BEHAVIOR

3

A study of the effects of social interaction upon individual behavior and personality; collective attitudes and behavior as products of group experience; analysis of fashions and fads, crowds, mobs, publics, social movements.

Both Sessions: 8:00-9:30, 9:50-11:20

Staff

SOC 303 CURRENT SOCIAL PROBLEMS

3

Study of the social and cultural aspects of specific problems such as crime, divorce, race conflict, illness, poverty, housing, recreation and personality adjustment to demonstrate the basic integration of society and community life.

First Session: 9:50-11:20

Second Session: 11:40-13:10

Staff

SOC 304 CONTEMPORARY FAMILY LIFE

3

The social organization of the family with special attention to socialization, marital choice, kinship relations, and the social changes affecting family structure and functions.

Second Session: 8:00-9:30

Staff

SOC 305 RACE RELATIONS

3

Analysis of race relationships both in the United States and throughout the world with particular emphasis on factors producing the changes taking place at the present time.

Both Sessions: 11:40-13:10

Staff

- SOC 306 CRIMINOLOGY** 3
 The study of causation, treatment, prevention and control of criminality and juvenile delinquency. Special emphasis is placed on socio-cultural theories of causation and on the examination of court and correctional systems for adults and juveniles. Arranged field trips.
 Both Sessions: 8:00-9:30 Staff
- SOC 501 (ED 501) LEADERSHIP** 3
Prerequisite: SOC 202 or equivalent
 A study of leadership in various fields of American life; analysis of the various factors associated with leadership; techniques of leadership. Particular attention is given to recreational, scientific and executive leadership procedures.
 Special three weeks session (June 24-July 12): Hours Arranged
 Dr. Young
- SOC 513 (ED 513) COMMUNITY ORGANIZATION** 3
Prerequisite: SOC 202 or equivalent
 Community organization is viewed as a process of bringing about desirable changes in community life. Community needs and resources available to meet these needs are studied. Democratic processes in community action and principles of community organization are stressed, along with techniques and procedures. The roles of leaders, both lay and professional, in community development are analyzed.
 Special three weeks session (June 24-July 12): Hours Arranged
 Dr. Mayo

SOIL SCIENCE

- SSC 420 SOIL AND PLANT ANALYSIS** 3
Prerequisites: PY 212, CH 215 or consent of instructor
 Analytical techniques and instrumentation commonly employed in chemical analysis of soils and plants.
 Second Session: Hours Arranged Gilliam
- SSC 590 SPECIAL PROBLEMS** Credits Arranged
Prerequisites: SSC 200, SSC 302
 Special problems in various phases of soils. Problems may be selected or will be assigned. Emphasis will be placed on review of recent and current research.
 Both Sessions: Hours Arranged Graduate Staff
- SSC 699 RESEARCH** Credits Arranged
Prerequisite: Graduate standing in soil science
 A maximum of six credits is allowed toward the master's degree, but any number toward the doctorate.
 Both Sessions: Hours Arranged Graduate Staff

SPEECH

SP 231	BASIC PUBLIC SPEAKING <i>Prerequisite: ENG 112</i> Preparation and delivery of various kinds of speeches: informative, entertaining, persuasive. (Equivalent to SP 230) Both Sessions: 8:00-9:30, 9:50-11:20 First Session: 11:40-13:10	3 Staff Staff
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STATISTICS (EXPERIMENTAL)

ST 361	INTRODUCTION TO STATISTICS FOR ENGINEERS I <i>Prerequisite: College algebra</i> Survey of statistical techniques useful to engineers and physical scientists. Includes elementary probability, frequency distributions, sampling variation, estimation of means and standard deviations, confidence intervals, significance tests, control charts, elementary least squares, curve fitting. First Session: 8:00-9:30	3 Staff
ST 511-S	EXPERIMENTAL STATISTICS I <i>Prerequisite: ST 311 or graduate standing</i> Basic concepts of statistical models and use of samples; variation, statistical measures, distribution, tests of significance, analysis of variance and elementary experimental design, regression and correlation, chi-square. First Session: 8:00-9:30	3 Staff
ST 512-S	EXPERIMENTAL STATISTICS II <i>Prerequisite: ST 511 or equivalent</i> Covariance, multiple regression, factorial experiments, individual degrees of freedom, incomplete block designs, experiments repeated over space and time. Second Session: 8:00-9:30	3 Staff
ST 541	(MA 541) THEORY OF PROBABILITY I (See Mathematics, page 58.)	3
ST 591	SPECIAL PROBLEMS Development of techniques for specialized cases, particularly in connection with thesis and practical consulting problems. Both Sessions: Hours Arranged	1-3 Staff
ST 619	(MA 619) TOPICS IN ADVANCED PROBABILITY <i>Prerequisites: ST 617, 618 (MA 617, 618)</i> Characteristic functions, infinitely divisible and stable laws, factorizations of probability distributions, law of iterated logarithm, random walks, fluctuation theory, martingales, ergodic theory, Markov processes, the Poisson process, further topics in stochastic processes,	3

applications.

Special 8½ weeks session (June 5-August 2): Hours Arranged
Wesler

ST 691 ADVANCED SPECIAL PROBLEMS 1-3

Prerequisites: ST 502 or equivalent, ST 552

Any new advance in the field of statistics which can be presented in lecture series as unique opportunities arise, including theory of sampling applied to survey design and analysis of linear models.

Both Sessions: Hours Arranged Staff

ST 699 RESEARCH Credits Arranged

A maximum of nine credits is allowed toward the Master of Science degree; no limitation on credits toward the doctorate.

Both Sessions: Hours Arranged Staff

TEXTILES

TX 201 FUNDAMENTALS OF TEXTILES 2

Prerequisite: MA 111 or MA 102

An introduction to the textile industry, including the history of the industry, products and their utilization. Presentation of the basic techniques of manufacturing, materials flow, terminology and calculations.

First Session: 8:00-9:00 Robinson

TC 203 TEXTILE CHEMISTRY 6

Prerequisites: CH 103, TX 301

A comprehensive course designed to familiarize the student with the chemical properties of all natural and man-made fibers, and the procedures used for scouring, bleaching and dyeing. Some emphasis is placed upon the relationship between molecular structure and physical properties; the principles and methods for producing man-made fibers are discussed; a brief survey of organic chemistry is included particularly those parts that relate to polymer chemistry.

First Session: LR 7:30-10:10; LB 13:40-16:20 Hayes

TX 301 FIBER AND YARN TECHNOLOGY 6

Prerequisite: TX 201

A basic study of the theory of fiber and yarn technology. Emphasis is placed on the transformation of fibrous materials into finished yarns. The principles of fiber properties, processing mechanisms and yarn structures are presented.

First Session: LR 7:30-10:10; LB 13:40-16:20 Shinn

TX 302 TECHNOLOGY OF FABRICS 6

Prerequisites: TX 201, TX 301

A basic study of the theory of woven fabric technology. Emphasis is placed on fabric construction, weave formation and geometry of

fabrics. Mechanisms for fabric construction and resulting fabric properties as related to raw materials and fabric construction are presented.

Second Session: LR 7:30-10:10; LB 13:40-17:20

Berry

- TX 304 FIBER AND YARN TECHNOLOGY 4**
Prerequisites: TX 302, TX 327
Technological and economic aspects of fiber and yarn processing including: packaging, production and efficiency levels; specialized yarn processes such as combing with economic justifications; design and use of specialty novelty yarns; economical and mechanical limitations of textile equipment.
Second Session: LR 7:30-9:00; LB 13:40-16:20
Pardue
- TX 327 TEXTILE MEASUREMENTS AND QUALITY CONTROL 4**
Prerequisites: TX 302, ST 361
Quality control methods for textile processing, with emphasis on the measurement by laboratory instruments and techniques, and including a study of the mechanical and natural influences involved.
First Session: LR 7:30-9:00; LB 13:40-16:20
Robinson
- TX 340 KNITTING PRINCIPLES 5**
Prerequisite: TX 301
Design, analysis and production of knitted fabrics, including flat, circular and warp types. The economic aspects of the knitting process as a method of clothing production. Introduction to garment design, production and marketing.
Second Session: LR 11:40-13:50; LB 13:40-16:20
Middleton
- TX 366 FABRIC TECHNOLOGY 4**
Prerequisite: TX 302
Technology and economic aspects of fabric construction, design and production. The classical weaves, their design, inherent uses, production techniques and types of looms required. Marketing methods with Worth Street and other trade rules and regulations. The loom as a production unit: types, nomenclature, basic and special mechanisms. Mill balance. Fabric defects.
First Session: LR 7:30-9:00; LB 13:40-16:20 TTh
Moser
- TC 421 FABRIC FINISHING I 2**
Prerequisite: TC 203—may not be used for credit by textile chemistry majors
A general course in fabric finishing designed for students not majoring in textile chemistry. Emphasis is placed on stabilization finishes, and on agents for water repellency, crease resistance, moth and mildew proofing, fire proofing, etc. Some mechanical finishing (such as crepeing, napping) is also included.
Second Session: LR 10:20-11:20
Hayes
- TX 430 CONTINUOUS FILAMENT YARNS 3**
Prerequisite: TX 301
A study of properties and processes applicable only to filament yarns

such as texturizing and bulking. Detailed studies of throwing systems, engineering requirement of equipment, and yarn property changes resulting from processing.

First Session: LR 9:10-10:10; LB 13:40-16:20 MW

Tucker

TX 436 STAPLE FIBER PROCESSING 3

Prerequisite: TX 301

A study of special systems of processing long staple, natural and man-made fibers, including woolen, worsted, direct spinning, Turbo Stapler or Pacific Converter, and sliver to yarn methods. New concepts and research findings as applied to all yarn processes.

Second Session: LR 9:10-10:10; LB 13:40-16:20 TTh

Pardue

TX 483 TEXTILE COST METHODS 3

Prerequisite: TX 302

A study of cost methods applicable to textile costing with emphasis on decision making. Interpretation of cost reports and their use in pricing and cost control.

Second Session: LR 11:40-13:10

Tucker

TX 490 DEVELOPMENT PROJECT I 1-3

Prerequisites: Senior standing, consent of instructor

A problem of independent study assigned to seniors in the major field of study serving also as the laboratory period for senior-level courses.

First Session: Hours Arranged

Porter

TX 525 ADVANCED TEXTILE MICROSCOPY 2

Prerequisite: TX 327

Experiments, lectures and demonstrations in more advanced techniques of textile microscopy. Detailed studies of structures of fibers covered in lecture series, and supplemented by experiments on lecture topics. Detailed study of all types of microscopes and their uses in textiles. Preparation of slides for photography. Uses of photomicrographic equipment.

First Session: LR 8:00-10:00

Porter

TX 590 SPECIAL PROJECTS IN TEXTILES 1-3

Prerequisites: TX 327, senior standing, consent of instructor

Special studies in either the major or minor field of the advanced undergraduate or graduate student. These special studies will take the form of current problems of the industry, independent investigations in the areas of textile testing and quality control, seminars and technical presentations, both oral and written.

Both Sessions: Hours Arranged

Hersh, Porter

TX 602 STAPLE FIBER STRUCTURES 3

Prerequisite: Graduate standing

Studies of advanced techniques in textile production; the technological aspects of fiber properties in relation to processing; studies of research findings and application of these to processing equipment.

First Session: Hours Arranged

Porter

TX 631	SYNTHETIC FIBERS	2
	<i>Prerequisite: TX 430 or TX 436 or equivalent</i>	
	Lectures and projects on advanced problems relative to the properties and processing of man-made continuous-filament and staple-fiber yarns.	
	Second Session: Hours Arranged	Hersh, Porter

TX 699	TEXTILE RESEARCH	Credits Arranged
	Problems of specific interest to the textile industry will be assigned for study and investigation. The use of experimental methods will be emphasized. Attention will be given to the preparation of reports for publication; the master's thesis may be based upon the data obtained.	
	Both Sessions: Hours Arranged	Hersh, Porter

TC 699	TEXTILE RESEARCH FOR TEXTILE CHEMISTRY	Credits Arranged
	Problems of specific interest to the textile industry will be assigned for study and investigation. The use of experimental methods will be emphasized. Attention will be given to the preparation of reports for publication. The master's thesis may be based upon the data obtained.	
	Both Sessions: Hours Arranged	Cates

ZOOLOGY

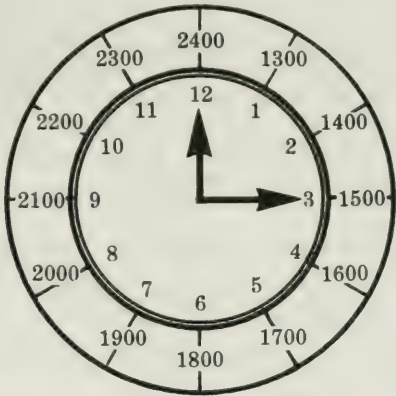
BS 100	GENERAL BIOLOGY	4
	(See Biological Sciences, page 24.)	

ZO 590	SPECIAL STUDIES	Credits Arranged
	<i>Prerequisites: Twelve hours zoology, consent of instructor</i>	
	A maximum of three credits allowed toward the bachelor's degree, six toward the master's, and nine toward the doctorate. The investigation of a particular problem in zoology.	
	Both Sessions: Hours Arranged	Graduate Staff

ZO 699	RESEARCH IN ZOOLOGY	Credits Arranged
	<i>Prerequisites: Twelve hours zoology, consent of instructor</i>	
	A maximum of six credits is allowed toward the master's degree; any number toward the doctorate.	
	Original research related to the student's thesis.	
	Both Sessions: Hours Arranged	Graduate Staff

INTERPRETATION OF TIME APPEARING IN THE SCHEDULE
OF COURSES

Class meeting times in this catalog are indicated in international time which is measured in hours numbered to 24 instead of 12.



If the schedule shows the class
beginning at:

The beginning hour in terms of a
12-hour clock is:

8	8:00 a.m.
9	9:00 a.m.
10	10:00 a.m.
11	11:00 a.m.
12	12:00 noon
13	1:00 p.m.
14	2:00 p.m.
15	3:00 p.m.
16	4:00 p.m.
17	5:00 p.m.
18	6:00 p.m.
19	7:00 p.m.
20	8:00 p.m.
21	9:00 p.m.
22	10:00 p.m.

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FRED J. ALLRED, Ph.D., Associate Professor of Modern Languages
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 KATHLEEN ANDERTON MCCUTCHEN, M.A., Research Instructor in Psychology

LELAND KITCHEN McDOWELL, M.S., Assistant Professor of Mathematics
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 ROBERT LEE MCGUIRE, Ph.D., Extension Associate Professor of Animal Science
 W. S. McNAMARA, M.S., Visiting Instructor in Forest Research
 JOHN JOSEPH MCNEILL, Ph.D., Associate Professor of Animal Science and Microbiology
 FRANCIS EDWARD MCVAY, Ph.D., Professor of Experimental Statistics
 GERHARD K. MEGLA, Ph.D., Adjunct Professor of Electrical Engineering
 JASPER DURHAM MEMORY, Ph.D., Professor of Physics
 LAWRENCE EUGENE METTLER, Ph.D., Associate Professor of Genetics
 ROBERT S. METZGER, Ph.D., Associate Professor of Social Studies
 WALTER EARL MEYERS, Ph.D., Assistant Professor of English
 HENRY MOORE MIDDLETON, JR., B.S., Assistant Professor of Knitting Technology
 JOSEPH LEONARD MIDDLETON, M.A., Associate Professor of Philosophy and Religion
 MARION L. MILES, Ph.D., Assistant Professor of Chemistry
 ROBERT DONALD MILHOLLAND, Ph.D., Assistant Professor of Plant Pathology
 CONRAD HENRY MILLER, Ph.D., Associate Professor of Horticultural Science
 GROVER CLEVELAND MILLER, Ph.D., Associate Professor of Zoology
 HOWARD GEORGE MILLER, Ph.D., Head and Professor of Psychology
 LATHAM L. MILLER, M.A., Associate Professor of Recreation Resources Administration
 ROBERT LOUIS MILLER, B.A., Instructor in Industrial and Technical Education
 HARISH CHANDER MINOCHA, Ph.D., Assistant Professor of Microbiology
 JE HANGIR FARHAD MIRZA, Ph.D., Assistant Professor of Civil Engineering
 WALTER JOSEPH MISTRIC, JR., Ph.D., Professor of Entomology
 RICHARD DOUGLAS MOCHRIE, Ph.D., Associate Professor of Animal Science
 CARL ALBERT MOELLER, Ed.D., Associate Professor of Industrial Arts
 ROBERT HARRY MOLL, Ph.D., Professor of Genetics
 DANIEL JAMES MONCOL, D.V.M., Associate Professor of Animal Science
 ROYALL TYLER MOORE, Ph.D., Assistant Professor of Botany and Plant Pathology
 CHARLES GALLOWAY MOREHEAD, Ed.D., Professor of Guidance and Personnel Services
 CHARLES GLEN MORELAND, Ph.D., Assistant Professor of Chemistry
 JOHN WESLEY MORGAN, M.A., Instructor in Chemistry
 WILLIAM EDWIN MOSER, B.S., Associate Professor of Textile Technology
 MARVIN KENT MOSS, Ph.D., Associate Professor of Physics
 TERUMI MUKAI, Ph.D., Associate Professor of Genetics
 WESLEY GRIGG MULLEN, Ph.D., Associate Professor of Civil Engineering
 CATHERINE R. MUMAW, Ph.D., Visiting Professor of Home Economics
 CAREY GARDNER MUMFORD, Ph.D., Professor of Mathematics
 RICHARD MONIER MYERS, M.S., Assistant Professor of Animal Science
 J. J. NAGLE, Ph.D., Assistant Professor of Biological Sciences
 HOWARD MOVES NAHIKIAN, Ph.D., Professor of Mathematics
 GENE NAMKOONG, Ph.D., Associate Professor (USFS) of Genetics and Forestry
 KENT DOUGLAS NASH, MBA, Instructor in Economics
 PAUL VICTOR NELSON, Ph.D., Assistant Professor of Horticultural Science
 JOSEPH TAFT NERDEN, Ph.D., Professor of Industrial Education
 WILLIAM BELTON NESBITT, Ph.D., Assistant Professor of Horticultural Science
 HERBERT HENRY NEUNZIG, Ph.D., Associate Professor of Entomology
 SLATER EDMUND NEWMAN, Ph.D., Professor of Psychology
 PAUL ADRIAN NICKEL, Ph.D., Professor of Mathematics
 LOWELL WENDELL NIELSEN, Ph.D., Professor of Plant Pathology
 DEMETRIOS FRANK NIXON, M.A., Instructor in History

GLENN RAY NOGGLE, Ph.D., Head and Professor of Botany
 ARNOLD NOLSTAD, Ph.D., Associate Professor of Mathematics
 CHARLES JOSEPH NUSBAUM, Ph.D., William Neal Reynolds Professor of Plant Pathology
 PHARES STEVENS NYE, M.S., Instructor in Engineering Graphics
 GEORGE MOTLEY OLIVER, M.S., Instructor in Chemistry
 DELMAR WALTER OLSON, Ph.D., Professor of Industrial and Technical Education and Coordinator of Graduate Studies in Industrial Arts
 JOHN BENJAMIN O'NEAL, JR., Ph.D., Assistant Professor of Electrical Engineering
 HUBERT LOWELL OWEN, B.S., Instructor in Physics
 ROBERT GUY OWENS, Ph.D., Adjunct Professor of Plant Pathology
 JAMES EDWIN PARDUE, B.S., Associate Professor of Textile Technology
 JAE YOUNG PARK, Ph.D., Assistant Professor of Physics
 CHARLES ALEXANDER PARKER, Ph.D., Associate Professor of English
 GEORGE WILLIAM PARKER, III, Ph.D., Assistant Professor of Physics
 BARBARA PARRAMORE, Ph.D., Visiting Instructor in Guidance and Personnel Services
 RICHARD ROLAND PATTY, Ph.D., Associate Professor of Physics
 LALJI JAYANHLAL PAVAGADHI, Ph.D., Assistant Professor of Mechanical and Aerospace Engineering
 ROBERT GASTON PEARCE, JR., M.S., Instructor in Engineering Mechanics
 RICHARD GUSTAVE PEARSON, Ph.D., Associate Professor of Psychology and Industrial Engineering
 JOHN NOBLE PERKINS, Ph.D., Associate Professor of Mechanical Engineering
 JEROME JOHN PERRY, Ph.D., Associate Professor of Microbiology
 LYNN McIVER PERRY, JR., Ph.D., Instructor in Mathematics
 DANIEL McLEOD PETERSON, M.A., Associate Professor of Mathematics
 WILBUR CARROLL PETERSON, Ph.D., Associate Professor of Electrical Engineering
 HOWARD ALDRIDGE PETREA, M.A., Associate Professor of Mathematics
 ROBERT McLEAN PINKERTON, B.S., Professor of Aeronautical Engineering
 GEORGE WAVERLY POLAND, Ph.D., Head and Professor of Modern Languages
 JOSEPH ALEXANDER PORTER, JR., M.S., Professor of Textile Technology
 IRA DEWARD PORTERFIELD, Ph.D., Head and Professor of Animal Science
 DILLARD MARTIN POWELL, MBA, Instructor in Textile Technology
 NATHANIEL THOMAS POWELL, Ph.D., Professor of Plant Pathology
 ALBERT ERNEST PURCELL, Ph.D., Associate Professor (USDA) of Food Science
 JOHN WILLIAM QUERRY, Ph.D., Associate Professor of Mathematics
 EMILY H. QUINN, Ph.D., Professor of Adult Education
 ROBERT LAMAR RABB, Ph.D., Professor of Entomology
 ALLEN HUFF RAKES, Ph.D., Associate Professor of Animal Science
 ROBERT TODD RAMSAY, Ph.D., Assistant Professor of Mathematics
 HAROLD ARCH RAMSEY, Ph.D., Professor of Animal Science
 JOHN OREN RAWLINGS, Ph.D., Associate Professor of Experimental Statistics
 THOMAS HOWARD REGAN, Ph.D., Assistant Professor of Philosophy and Religion
 PRESTON HARDING REID, Ph.D., Professor of Soil Science
 WILLIS ALTON REID, Ph.D., Professor of Chemistry
 RICARDO REINOSO, B.S.B.A., Instructor in Economics
 CHARLES RUSSELL REYNOLDS, Ph.D., Assistant Professor of Modern Languages
 MICHAEL SHANE REYNOLDS, M.A., Instructor in English
 MAX STEVE RHODES, M.A., Assistant Professor of Physical Education
 DARRELL L. ROBERTS, M.S., Instructor in Biological and Agricultural Engineering
 JOHN FREDERICK ROBERTS, Ph.D., Assistant Professor of Zoology
 WILLIAM MILNER ROBERTS, Ph.D., Head and Professor of Food Science

MENDEL LENO ROBINSON, JR., M.S., Instructor in Textile Research
 ODIS WAYNE ROBISON, Ph.D., Associate Professor of Animal Science
 GEORGE CALVERT ROCK, Ph.D., Assistant Professor of Entomology
 CHARLES N. ROGERS, B.S., Associate Professor of Wood Science and Technology
 DON DEAN ROSE, M.A., Instructor in English
 JOHN PAUL ROSS, Ph.D., Professor (USDA) of Plant Pathology
 GEORGE DARRELL RUSSELL, Ph.D., Assistant Professor of Adult Education
 PAUL JAMES RUST, Ph.D., Associate Professor of Psychology
 HANS SAGAN, Ph.D., Professor of Mathematics
 HERBERT ARTHUR SANDMAN, LLB, Instructor in Economics
 JOSEPH NEAL SASSER, Ph.D., Professor of Plant Pathology
 ROBERT G. SAVAGE, M.S., Instructor in Mathematics
 MAN MOHAN SAWHNEY, Ph.D., Assistant Professor of Sociology and Anthropology
 LEROY CHARLES SAYLOR, Ph.D., Associate Professor of Genetics and Forestry and Assistant to the Dean of Forest Resources
 CLARENCE CAYCE SCARBOROUGH, Ed.D., Head and Professor of Agricultural Education
 HENRY ELKIN SCHAFFER, Ph.D., Assistant Professor of Genetics
 HANS T. SCHREUDER, Ph.D., Instructor in Forestry and Experimental Statistics
 WILFRED MARTIN SCHUTZ, Ph.D., Research Assistant Professor (USDA) of Genetics
 THOMAS E. SCISM, Ph.D., Assistant Professor of Politics
 LEWIS WORTH SEAGONDOLLAR, Ph.D., Head and Professor of Physics
 WAYLAND PRITCHARD SEAGRAVES, M.S., Assistant Professor of Electrical Engineering
 LOUIS WALTER SEEGER, M.A., Professor of History
 HARRY EDWARD SEIDEL, Ph.D., Visiting Associate Professor of Psychology
 PETER SHAHDAN, M.S., Assistant Professor of Mathematics
 HENRY ANTHONY SHANNON, Ed.M., Assistant Professor of Mathematics and Science Education
 GRAYE JOHNSON SHAW, M.S., Instructor of Chemistry
 WILFRED MICHAEL SHEA, M.E., Assistant Professor of Physical Education
 D. O. SHEEHAN, M.A., Instructor in Mathematics
 THOMAS JACKSON SHEETS, Ph.D., Associate Professor of Entomology and Crop Science
 ALFRED BERNARD ROWLAND SHELLEY, M.A., Associate Professor of English
 ROBERT TINSLEY SHERWOOD, Ph.D., Associate Professor (USDA) of Plant Pathology
 PAULINUS SHEE-SHAN SHIEH, M.S., Instructor in Physics
 ROBERT WEATHERSBEE SHINN, M.S., Instructor in Textile Technology
 THOMAS CLINARD SHORE, JR., M.I.A., Assistant Professor of Industrial and Technical Education
 SOFUS EMMELO SIMONSEN, M.A., Assistant Professor of Modern Languages
 EDWARD CARROLL SISLER, Ph.D., Associate Professor of Biochemistry and Crop Science
 CHARLES SMALLWOOD, JR., M.S., Professor of Civil Engineering
 ELIZABETH ANN SMALTZ, B.S., Instructor in Physical Education
 BENJAMIN WARFIELD SMITH, Ph.D., Professor of Genetics
 CLYDE FUHRMAN SMITH, Ph.D., Professor of Entomology
 FARMER STERLING SMITH, M.A., Instructor in Industrial Education
 FRANK HOUSTON SMITH, M.S., Professor of Animal Science
 J. C. SMITH, Ph.D., Assistant Professor of Civil Engineering
 NORWOOD GRAHAM SMITH, M.A., Assistant Professor of English

VIRGINIA SLAYTON SMITH, M.A., Instructor in Modern Languages
 WILLIAM EDWARD SMITH, Ed.D., Professor of Physical Education
 WILLIAM E. SMITH, Ed.D., Professor of Recreation Resources Administration
 WILLIAM HENRY SONNER, M.Ed., Assistant Professor of Physical Education
 JASON LOY SOX, JR., M.S., Instructor in Mathematics
 MARVIN LUTHER SPECK, Ph.D., William Neal Reynolds Professor of Food Science
 and Microbiology
 HERBERT ELVIN SPEECE, Ph.D., Head and Professor of Mathematics and Science
 Education
 GEORGE S. SPEIDEL, JR., M.A.T., Assistant Professor of Mathematics
 WILLIAM ELDON SPLINTER, Ph.D., Professor of Agricultural Engineering
 EDWARD M. STACK, Ph.D., Professor of Modern Languages
 HANS HEINRICH ANTON STADELMAIER, Ph.D., Research Professor of Metallurgy
 DONALD BENNETT STAFFORD, M.S., Instructor in Civil Engineering
 ALFRED J. STAMM, Ph.D., Reuben B. Robertson Professor of Wood Chemistry
 DONALD HENRY JOHN STEENSEN, Ph.D., Assistant Professor of Forestry and
 Wood Science and Technology
 STANLEY GEORGE STEPHENS, Ph.D., William Neal Reynolds Professor of Genetics
 ROBERT ELMER STERNLOFF, Ph.D., Assistant Professor of Recreation Resources
 Administration
 EDWARD HOYLE STINSON, B.S., Instructor in Engineering Graphics
 DAVID LEWIS STRIDER, Ph.D., Associate Professor of Plant Pathology
 RAYMOND ALDRICH STRUBLE, Ph.D., Professor of Mathematics
 CHARLES WILLIAM STUBER, Ph.D., Assistant Professor (USDA) of Genetics
 CHARLES WILSON SUGGS, Ph.D., Associate Professor of Agricultural Engineering
 PAUL PORTER SUTTON, Ph.D., Professor of Chemistry
 STANLEY SUVAL, Ph.D., Assistant Professor of History
 HAROLD EVERETT SWAISGOOD, Ph.D., Associate Professor of Food Science
 FRED RUSSELL TARVER, JR., Ph.D., Extension Associate Professor of Food Science
 FRANK BANCROFT THOMAS, Ph.D., Extension Professor of Food Science
 RICHARD JOSEPH THOMAS, Ph.D., Associate Professor of Wood Technology
 OLIVER GEORGE THOMPSON, M.A., Assistant Professor of Economics
 DAVID RONALD TILLEY, Ph.D., Associate Professor of Physics
 FREDERICK JOSEPH TISCHER, Ph.D., Professor of Electrical Engineering
 HAROLD LESLIE TITUS, M.A., Assistant Professor of Modern Languages
 EDWARD SHERMER TODD, M.S., Instructor in Engineering Mechanics
 FRED TONEY, M.S., Instructor in Mathematics
 WILLIAM BELL TOOLE, III, Ph.D., Associate Professor of English
 SAMUEL B. TOVE, Ph.D., Professor of Animal Science and Biochemistry
 ANASTASIOS CHRISTOS TRIANTAPHYLLOU, Ph.D., Associate Professor of Genetics
 HEDWIG HIRSCHMANN TRIANTAPHYLLOU, Ph.D., Professor of Plant Pathology
 ROBERT TINNEN TROXLER, M.I.A., Assistant Professor of Industrial Arts
 JAMES RICHARD TROYER, Ph.D., Associate Professor of Botany
 HARRY TUCKER, JR., Ph.D., Associate Professor of Modern Languages
 PAUL ARTHUR TUCKER, JR., M.S., Research Instructor in Textile Technology
 WILLIAM PRESTON TUCKER, Ph.D., Associate Professor of Chemistry
 CARL BYRON TURNER, Ph.D., Associate Professor of Economics
 CHARLES HENRY UFEN, M.A., Assistant Professor of Economics
 LESTER CURTISS ULBERG, Ph.D., Professor of Animal Science
 DAVID FREDERICK ULLRICH, Ph.D., Assistant Professor of Mathematics
 MEHMET ENSAR UYANIK, Ph.D., Professor of Civil Engineering
 WILLIAM JOHN VANDERWALL, M.A., Instructor in Engineering Graphics
 RICHARD JAMES VOLK, Ph.D., Professor of Soil Science
 GEORGE HENRY WAHL, JR., Ph.D., Assistant Professor of Chemistry

HARVEY EDWARD WAHLS, Ph.D., Associate Professor of Civil Engineering
 JERRY MARVIN WALLER, M.S.Met.E., Instructor in Metallurgy
 WILLIAM M. WALTER, Ph.D., Assistant Professor of Food Science
 ARTHUR WALTER WALTNER, Ph.D., Professor of Physics
 THOMAS MARSH WARD, Ph.D., Instructor in Chemistry
 GROVER KARL WARMBROD, M.S., Instructor in Mathematics
 FREDERICK GAIL WARREN, Ph.D., Professor of Food Science
 WILLIAM IRVIN WARREN, B.S., Instructor in Engineering Graphics
 GEORGE CARSON WATSON, M.A., Associate Professor of Mathematics
 JAMES DONALD WATSON, M.S., Instructor in Mathematics
 JOHN WILLIS WEAVER, JR., B.S., Professor of Agricultural Engineering
 RONALD GILBERT WEAVER, B.S., Instructor in Physical Education
 BENJAMIN DAVIS WEBB, M.S., Instructor in Engineering Graphics
 NEIL BROYLES WEBB, Ph.D., Associate Professor of Food Science
 STERLING BARG WEED, Ph.D., Associate Professor of Soil Science
 FREDERICK LOVEJOY WELLMAN, Ph.D., Visiting Professor of Plant Pathology
 RONALD EARLE WELTY, Ph.D., Assistant Professor (USDA) of Plant Pathology
 OSCAR WESLER, Ph.D., Professor of Experimental Statistics and Mathematics
 BERT WHITLEY WESTBROOK, Ed.P., Research Assistant Professor of Psychology
 RAYMOND CYRUS WHITE, Ph.D., Professor of Chemistry
 ROBERT BENJAMIN WHITE, JR., Ph.D., Assistant Professor of English
 JAMES CLIFFORD WILLIAMS, III, Ph.D., Professor of Mechanical Engineering
 MARY CAMERON WILLIAMS, M.A., Special Lecturer in English
 PORTER WILLIAMS, JR., M.A., Associate Professor of English
 JACK WILFRED WILSON, Ph.D., Assistant Professor of Economics
 JAMES BLAKE WILSON, Ph.D., Associate Professor of Mathematics
 LOWELL SHERIDAN WINTON, Ph.D., Professor of Mathematics
 GEORGE HERMAN WISE, Ph.D., William Neal Reynolds Professor of Animal
 Science and Head of Nutritional Biochemistry Section
 MILTON BEE WISE, Ph.D., Professor of Animal Science
 EDWARD HEMPSTEAD WISER, Ph.D., Associate Professor of Agricultural Engi-
 neering
 WILLIAM GARLAND WOLTZ, Ph.D., Professor of Soil Science
 THOMAS WILMONT WOOD, Ph.D., Professor of Economics
 WILLIAM WALTON WOODHOUSE, JR., Ph.D., Professor of Soil Science
 ROBERT BAKER WYNN, M.A., Associate Professor of English
 ROBERT TAKICHI YAMAMOTO, Ph.D., Associate Professor of Entomology
 JAMES WESLEY YORK, JR., Ph.D., Assistant Professor of Physics
 DAVID ALLEN YOUNG, JR., Ph.D., Professor of Entomology
 JAMES HERBERT YOUNG, Ph.D., Assistant Professor of Biological and Agricul-
 tural Engineering
 JAMES NEAL YOUNG, Ph.D., Associate Professor of Sociology and Anthropology
 TALMAGE BRIAN YOUNG, Ed.D., Associate Professor of Industrial Arts
 PAUL ZUNG-TEH ZIA, Ph.D., Associate Head and Professor of Civil Engineering
 BRUCE J. ZOBEL, Ph.D., Edwin F. Conger Professor of Forest Genetics
 JOSEPH DAVID ZUND, Ph.D., Associate Professor of Mathematics

CAMPUS
NORTH CAROLINA STATE UNIVERSITY
at Raleigh





1. HOLLADAY
2. ALUMNI
3. PRIMROSE
4. SULLIVAN
5. PEELE
6. WATAUGA
7. BROOKS
- *8. CHEMISTRY BUILDING
9. GOLD
10. WELCH
11. BAGWELL
12. BERRY
13. BECTON
14. CLARK
15. THOMPSON THEATRE
16. SYME
17. FIELD HOUSE
- *18. FORESTRY BUILDING
19. KING
20. LEAZAR
21. LEE
22. TOMPKINS
23. WINSTON
24. CERAMICS
25. PAGE

26. PARK SHOPS
27. MORRIS
28. LAUNDRY
29. POWER PLANT
30. RIDDICK
31. DANIELS
32. MANN
33. WITHERS
34. 1911 BUILDING
35. RICKS
36. PATTERSON
37. BURLINGTON NUCLEAR LABS
38. WILLIAM NEAL REYNOLDS COLISEUM
39. CARMICHAEL GYMNASIUM
41. ALEXANDER
42. STUDENT SUPPLY STORE
43. BUREAU of MINES
44. BROUGHTON
45. POLK
46. HARRELSON
47. D. H. HILL LIBRARY
48. ERDAHL-CLOYD UNION
49. SCOTT
50. GARDNER

51. WILLIAMS
52. AGRONOMY GREENHOUSES
53. PHYSICAL SCIENCES LAB BUILDING
54. OWEN
55. TURLINGTON
56. TUCKER
57. CAFETERIA
58. KILGORE
59. NELSON
60. MANGUM
61. PRINT SHOP
62. BRAGAW
63. BRANDON F. HODGES
64. ROBERTSON
65. AGRICULTURAL ENGINEERING
66. ANIMAL DIAG LABORATORY
67. WUNC-TV
68. MARRIED STUDENT HOUSING
69. FRATERNITY HOUSING
- *70. PHYTROTRON
- *71. BIOLOGICAL SCIENCES
- *72. FOOD SCIENCE BUILDING
- *73. WOMEN'S DORMITORIES
- *74. DORM 65

* BUILDINGS IN DEVELOPMENT STAGE



Seventy ninth

Annual Commencement

North Carolina State University at Raleigh

Saturday, May 25

Nineteen Hundred and Sixty eight

Degrees Awarded 1967-68

*Corrections on pages : 14(2), 18(2),
21, 25, 26(2), 27(2), 36*

Musical Program

EXERCISES OF GRADUATION

MAY 25, 1968

CARILLON CONCERT: 9:30 A.M.

Albert Hardy, Jr., Carillonneur

The Memorial Tower

COMMENCEMENT BAND CONCERT: 9:45 A.M.

William Neal Reynolds Coliseum

March for the Sultan Abdul Medjid	Donizetti
Cantique and Faranade	McBeth
Symphony No. 5 in C Minor, First Movement	Beethoven
Festive Overture, Op. 96	Shostakovich

PROCESSIONAL: 10:15 A.M.

March Processional	Grundman
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RECESSIONAL:

University Grand March	Goldman
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NORTH CAROLINA STATE UNIVERSITY COMMENCEMENT BAND

Donald B. Adcock, Conductor

The Alma Mater

Words by:

ALVIN M. FOUNTAIN, '23

Music by:

BONNIE F. NORRIS, JR., '23

Where the winds of Dixie softly blow
o'er the fields of Caroline,

There stands ever cherished N. C. State,
as thy honored shrine.

So lift your voices! Loudly sing
from hill to oceanside!

Our hearts ever hold you, N. C. State,
in the folds of our love and pride.

Exercises of Graduation

William Neal Reynolds Coliseum

May 25, 1968

PROCESSIONAL, 10:15 A.M. Donald B. Adcock
Conductor, North Carolina State University Commencement Band

The audience is requested to remain
seated during the Processional.

PRESIDING John Tyler Caldwell
Chancellor, North Carolina State University

INVOCATION Oscar B. Wooldridge
*Coordinator of Religious Affairs
North Carolina State University*

ADDRESS John Tyler Caldwell
Chancellor

CONFERRING OF DEGREES John Tyler Caldwell
Chancellor

Harry C. Kelly
Provost

Candidates for baccalaureate degrees presented
by Deans of Schools. Candidates for advanced
degrees presented by Dean of the Graduate
School. Candidates for honorary degrees
presented by their sponsors.

ANNOUNCEMENT OF GOODWIFE DIPLOMAS Robert Gray Shipley
Vice-President of Student Government

RECOGNITION OF OUTSTANDING TEACHERS Harry C. Kelly
Provost

ANNOUNCEMENT OF OUTSTANDING TEACHER

AWARDS Iain Alasdair Fraser
President, Class of 1968

REMARKS TO THE GRADUATING CLASS Dan K. Moore
Governor of North Carolina

William C. Friday
President, University of North Carolina

ALMA MATER

BENEDICTION

RECESSIONAL

The audience is requested to remain seated
until recessional music is concluded.

Social Hour and Distribution of Diplomas

School and Department Locations

12:15 P.M.

School of Education Carmichael Gymnasium
School of Liberal Arts Harris Cafeteria

12:40 P.M.

Department of Engineering Operations Raleigh Little Theatre Amphitheatre

1:30 P.M.

School of Agriculture and Life Sciences

Adult Education Carmichael Gymnasium
Agronomy, Crop Science, Plant Protection
and Soil Science Williams Hall Auditorium and
McKimmion Room, Williams Hall
Animal Science Fitzpatrick Room, 125 Polk Hall
Biological and Agricultural
Engineering 158 Agricultural Engineering Building
Biological Sciences and Botany 2213 Gardner Hall
Economics 256-258 Erdahl-Cloyd Union
Food Science Food Science Building
Genetics 3516 Gardner Hall Addition
Horticultural Science 125 Kilgore and 121 Kilgore Hall
Poultry Science 224 Scott Hall
Zoology 3533 Gardner Hall

School of Design Erdahl-Cloyd Union Ballroom

School of Engineering

Agricultural Engineering 158 Agricultural Engineering Building
Chemical Engineering Erdahl-Cloyd Union Gallery
Civil Engineering Lobby of Mann Hall
Electrical Engineering Thompson Theatre
Engineering Mechanics 119 Riddick Hall
Furniture Manufacturing and Management 222 Riddick Hall
Industrial Engineering 234 Riddick Hall
Mechanical Engineering 216 Broughton Laboratories
Mineral Industries Parlor, King Religious Center
Nuclear Engineering Burlington Nuclear Laboratories

School of Forest Resources 162 Kilgore Hall

School of Physical Sciences and

Applied Mathematics General Laboratory Building

School of Textiles Nelson Textile Auditorium

ROTC Commissioning Ceremony

William Neal Reynolds Coliseum

May 25, 1968

PROCESSIONAL MARCH 3:00 P.M. Donald B. Adcock
Conductor, North Carolina State University Commencement Band

The audience is requested to remain seated
until processional music is completed.

NATIONAL ANTHEM

INVOCATION Oscar B. Wooldridge
Chaplain (Lieutenant Commander), USNR-Ret.

INTRODUCTIONS John Tyler Caldwell
Chancellor, North Carolina State University

ADDRESS Richard J. Seitz
Major General, U.S. Army
Commanding General, 82d Airborne Division

ADMINISTRATION OF OATH
OF OFFICE Colonel Paul V. Tuttle, PMS
Colonel Samuel G. Schlitzkus, PAS

PRESENTATION OF CERTIFICATES
OF COMMISSION Major General R. J. Seitz—U.S. Army
Brigadier General F. S. Smith—U.S. Air Force

BENEDICTION

Academic Costume

Academic gowns represent a tradition handed down from the universities of the Middle Ages. These institutions were founded by the Church; the students, being clerics, were obliged to wear the prescribed gowns at all times. Round caps later became square mortarboards; the hoods, originally cowls attached to the gowns, could be slipped over the head for warmth.

Many European universities have distinctive caps and gowns which are different from those commonly used in this country. Some of the gowns are of bright colors and some are embellished with fur. A number of these may be noted in the procession.

The usual color for academic gowns in the United States is black. The bachelor's gown is worn closed, the master's and doctor's may be worn open or closed. The shape of the sleeve is the distinguishing mark of the gown: bachelor—long pointed sleeves; master—oblong, square cut in back with an arc cut away in front; doctor—bell shaped.

Caps are black as are the tassels for B.A., B.S., and B.E. degrees; tassels for the Ph.D. degree are gold and those for other graduate and professional degrees may be of the color corresponding to the trimmings on the hoods.

The hoods are lined with the color of the institution from which the wearer received his degree. The trimming or collar of the hood is the color which designates the degree: Liberal Arts, white; Fine Arts and Architecture, brown; Science, golden yellow; Music, pink; Divinity, scarlet; Law, purple; Engineering, orange; Philosophy, blue; Medicine, green; Forestry, russet.

Honorary degree hoods are distinguished as follows: Master of Arts (M.A.), white; Doctor of Humane Letters (L.H.D.), white; Doctor of Science (Sc.D.), golden yellow; Doctor of Divinity (D.D.), scarlet; Doctor of Laws (L.L.D.), purple.

DEGREES CONFERRED

May 25, 1968

School of Agriculture and Life Sciences



BACHELOR OF SCIENCE IN BIOLOGICAL AND AGRICULTURAL ENGINEERING

Jointly Administered by the School of Agriculture and Life Sciences
and the School of Engineering

John Hamlett Merritt, III	Roxboro
Patrick Safrit Smith	Beaufort

BACHELOR OF SCIENCE

Agricultural Economics

Vernon Charles Ballard	Fuquay-Varina
Thomas McKenzie Crews, Jr.	Oxford
Porter Christy Little, III	Pittstown, N. J.
David Wright Miller, Jr.	Snow Hill
Ralph Sylvester Morgan	Smithfield
John Atlas Mullis	Lenoir
Randy Eichman Niederer	Titusville, N. J.
Joseph Hanes Stilwell	Danville, Va.
† Bobby Graham White	Burlington

Agronomy

Charles Everett Brown, III	Shawboro
David Thomas Rozzell	Swannanoa
John Martin Scott, Jr.	Milton
Leland McKinley Simmons	Newport
Larry Wayne Stewart	Elkin
Richard Martin Sumrell	Snow Hill

• Honors •• High Honors # Honors Program † In Absentia

Leon Randolph Whichard, Jr.	Jackson
#•William Herbert Williams	Hertford

Animal Science

Robert Wilson Gudger, Jr.	Charlotte
John Vann Hall	Aulander
Clement Michael Holthouser	Mooreville
*•Marvin Boyd Newlin	Mebane
Charles Grainger Pierce	Weldon
†Eugene Jule Richmond	Durham
William Valentine Roessler, III	Winston-Salem
Larry Wayne Stewart	Elkin

Biological and Agricultural Engineering

Charles Franklin Boyles, Jr.	Charlotte
Thomas Lee Caviness, Jr.	Fuquay-Varina
Robert Joseph Cooke	Four Oaks
Gurney Reece Dillard	North Wilkesboro
Thomas Francis Drake	Lexington, Va.
Manuel Mejia	Bogota, Colombia
*Roy Dean Rhue	Winston-Salem
Morris Glenn Skipper	Abbottsburg
†Ronald Edward Wheeler	Angier
Donald Wayne White	Williamston
Kenneth Alvin Worthington	Snow Hill

Biological Sciences

#Carroll Lennell Allen	Cary
Charles Waller Arthur, II	Candler
Robert Gordon Carson, III	Raleigh
#••Robert Ray Jackson	Pittsboro
Barbara Jean Miller	Altavista, Va.
#•David Thomas Patterson	Hillsborough
†John Wesley Weber, Jr.	Raleigh

Botany

Jane Green McNeary	Charlotte
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Crop Science

Patrick Henry Harper	Kinston
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Food Science

Margaret Anne Cooke	Cleveland
*Freida Ann Eaker	Cherryville
Robert Lionel Stark	Pennsauken, N. J.
*John Robert Woodard, Jr.	Spring Hope
George Henry Worsham	Rutherfordton

• Honors •• High Honors # Honors Program † In Absentia

Horticultural Science

#•Elwood Lee Cumbo	New Bern
John Thomas Davis	Lumberton
Elliott Keith Hornbeck	Richmond, Va.
Thomas Dwight Talley	Reidsville

Plant Protection

#•Ronald Perry Thompson	Lucama
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Poultry Science

Joseph Jackson Edmondson, II	Maury
John Warren Jackson	Henderson
Harlen James Price, Jr.	Monroe
Robert Otis Triplett	Rutherfordton
Wayne Aubrey Ward	Denton

Soil Science

James Hamilton Ware, Jr.	Turkey
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Zoology

#•Neal Ashley Adkins, Jr.	Rocky Mount
George Ruffin Benton, III	Goldsboro
†Michael George Bolus	Raleigh
†Frederick C. Bonner	Aurora
Jonathan Wesley Bost	Kings Mountain
Robert LeRoy Busch, Jr.	Cynthiana, Ky.
Timothy Michael Cleary	Southern Pines
Michael Dale Collins	Mechanicsburg, Penna.
Christina Harding Coltrane	Madison
Richard Martin Cooper	Asheboro
John Lambert Cottingham, III	Durham
#•John Kent Crawford	North Wilkesboro
•Cecil Murray Farrington, Jr.	Granite Quarry
•Jeffrey David Gnad	Sea Cliff, N. Y.
Robert Wilson Gudger, Jr.	Charlotte
Mack Raymond Horrell	Atkinson
••Robert Marshall Horton	Raleigh
James Thomas Jennings	Raleigh
#•Lawrence Edward Lykins	Atlanta, Ga.
Danny Blair Magoun	Indianapolis, Ind.
Donald Johnson Manley	Reidsville
Barbara Jean Miller	Altavista, Va.
Evans Wayne Miller	Sparta
Harold Gomer Morgans	Pittsburgh, Penna.
•David Allen Pennell	Boomer
Barnard Hodge Powell	Wake Forest
Lloyd Hildres Rawls	Fayetteville
†•John Bennit Renfro	Cary
•James Odell Richardson, Jr.	Stokesdale
Kenneth Ray Russell	Raleigh

• Honors

•• High Honors

Honors Program

† In Absentia

Ronnie Leroy Shell	Black Mountain
#••John Vikram Thomas	Charlotte
••Lynda Rigsbee Weston	Durham
James Alton Whitehurst	Raleigh
James Brogden Womble, III	Aberdeen
#•Richard Charles Yates	Absecon, N. J.
†James Byron Zuver	Burnsville

School of Design



BACHELOR OF ARCHITECTURE

William Leonard Ambrose, III	Knoxville, Tenn.
Samuel William Brockwell	Durham
John Charles Brown	Norfolk, Va.
Coleman Hughes Bynum, Jr.	Jacksonville
†Wallace Vanamber Calvert, Jr.	Raleigh
Christina Chih-Lin Chen	Taipei, China
Joseph Albert Chipman	Raleigh
Randolph Rudisill Croxton	Lincolnton
John Albert DeMartini	Midland Park, N. J.
James Francis Dugan, III	Orangeburg, S. C.
Michael Alan Fields	Rockville, Md.
•Margaret Marie Garey	Easton, Md.
•Reinhard Karl Goethert	Manchester, Tenn.
•Richard John Green	Painesville, Ohio
Charles Durham Harris	Enfield
Frank Mackey Hough, Jr.	Charlotte
David Ward Jones	Raleigh
•John Wesley Kinney, Jr.	Winston-Salem
John Earl Lawrence	Tarboro
William Lucian McGee	Asheville
Novem Miller Mason	Morehead City
John Edward Moyer	La Plata, Md.
Harold Lee Ogburn	Smithfield
William James Patrick	Shawboro
Edward Shelton Payne	Silver Spring, Md.
Irvin Alexander Pearce	Greensboro
John David Ramseur	Charlotte
James Edward Rink, Jr.	Charlotte
Marshall Brice Roberts	Weaverville
•James Hassell Ross, Jr.	Raleigh
Faset Joaquin Seay	Bryson City

• Honors

•• High Honors

Honors Program

† In Absentia

Stephan Leslie Setzer	High Point
Thomas Matson Shadoin, Jr.	Greensboro
John Charles Stec	Charleston, W. Va.
Betty Cushing Surbeck	Cheshire, Conn.
Paul Kirksey Thames, Sr.	Hope Mills
•Hal Hodges Tribble	Asheville
John Frederick Warren	Princeton, N. J.
Donald LeRoy Whitesell	High Point

Bachelor of Landscape Architecture

Peter Frederic Bochenek	McLean, Va.
•Donald Lynn Collins	Charlotte
Patricia Rae Hale	Aiken, S. C.
•Randolph Thompson Hester, Jr.	Roxboro
William Karl Hube, Jr.	Raleigh
Thomas Gene Martin	Greensboro
George Arthur Stockton, III	Winston-Salem
Claude Lawrence Vaughan, III	Shelby

Bachelor of Product Design

Lewis Franklin Bost	Shelby
Stuart Alan Cook	Salisbury
Philip Warren Cotton	Roanoke, Va.
Joe Reid Covington, Jr.	Winston-Salem
James Douglas Ezell	Charlotte
John Walter Harvey	Statesville
George Roger Hollomon, Jr.	Murfreesboro
Robert Springs Pharr	Charlotte
John Davis Sims, Jr.	Troutman
Kenneth Thompson, II	Waynesville
Lawrence Daniel Tracy	Chapel Hill
Donald McQueen White, III	Mount Pleasant, S. C.

School of Education



BACHELOR OF SCIENCE IN EDUCATION

Agricultural Education

Reuben Richard French, Jr.	Reidsville
Billy Joe Henson	Vilas
Jerry Thomas Holland	Holly Springs

• Honors •• High Honors # Honors Program † In Absentia

Tyree Bennett Holland, Jr.	Apex
Earl Jennings Huffman, Jr.	Richlands
Ivey Elliott Peterson	Clinton
Alton Douglas Powell	Seven Springs
Ricky Alfred Setzer	Claremont
Michael Ray Smith	Morganton

[] Jean Frank Simpson Marshville*

Industrial Arts Education

Michael David Daniska	Collinsville, Va.
Clinton David Harley	Newland
Russell Gerald Stafford	Monroe

Mathematics Education

Donald Earl Beal	Durham
Carolyn Louise Caudle	Charlotte
••Judy Adams Gealy	Benson
••Patty Sue Greene	Boiling Springs
Dennis Karl Macklin	Elizabeth City
Walker Lynn Oldham	Goldston
†Peter Sokalsky, Jr.	Allentown, Penna.
••Jane Cornwell Warren	Lincolnton

Science Education

Anne O'Berry Austin	Four Oaks
Dennis Harry Ballard	Hendersonville
William Thomas Lawson, Jr.	Fairmont, W. Va.
Judy Mac O'Neal	Raleigh

Technical Education

Percy White West	Sanford
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Vocational Industrial Education

Elbert Ronald Batten	Clayton
Frank Cleveland Miller	Charlotte

BACHELOR OF SCIENCE IN INDUSTRIAL ARTS

[] John Bowman Brookbank, Jr. Winston-Salem*

Mont Wesley Baker, Jr.	Swannanoa
Arthur John McMahon	Carteret, N. J.
Paul William Moore	Harmony
Ralph Rigdon White, Jr.	Greensboro

• Honors

•• High Honors

Honors Program

† In Absentia

School of Engineering



BACHELOR OF SCIENCE IN AEROSPACE ENGINEERING

John Huske Anderson, II	Fayetteville
Alvin Kermit Bailey, Jr.	Chapel Hill
Michael Coleman Bateman	Durham
#•Ronald Franklin Davis	Greensboro
Gary James Engels	Greensboro
David Briles Farlow	Asheboro
Francis Joseph Fisher, Jr.	Candler
Wayne Curtis Fisher	Norfolk, Va.
Samuel Thomas Hicks, III	Rolesville
•William Lincoln Hirst, Jr.	Fayetteville
•Jesse Luther Jackson, III	Kinston
Timothy Alexander Jordan	Charlotte
•Keith Lee Kushman	Cary
Glenn Logan Martin	Mount Airy
•Frank George Rezeli	Fayetteville
Ronald Dean Roberts	Rockingham
Asa Doshier Ruark, III	Southport
William Peter Ruzzo	Beachwood, N. J.
Edwin Paul Setzer	Hickory
Thaddeus William Shore	Boonville
Ronald Williams Shoulars	Kinston
Lorimer Phillip Thomas	Sanford
#••Charles Clark Thompson	Suffolk, Va.
John Wilson Warr, III	Hamlet
Johnie Easton Williams	Shallotte

BACHELOR OF SCIENCE IN CERAMIC ENGINEERING

Howard Burgess Chambers, Jr.	Winston-Salem
•James Frederick Holzgraf	Ramsey, N. J.
Douglas Hill Sawyer	Winston-Salem
Robert Patrick Steinmetz	Oradell, N. J.
†William Roger Swiss, Jr.	North Arlington, N. J.

BACHELOR OF SCIENCE IN CHEMICAL ENGINEERING

#•William Glenn Adams, Jr.	Greensboro
#••Ronald James Baer	Statesville
Lynwood Joseph Bell	Smithfield
•Thomas Joseph Chastant	Pine Bluff, Ark.
Anthony Thomas Dombroski, Jr.	Castle Hayne
•James Chadwick Henderson	Hendersonville
Jeffrey Bruce Herman	Philadelphia, Penna.

• Honors •• High Honors # Honors Program † In Absentia

George Gregory Hicks	Greensboro
Michael Ownby Hixson	Charlotte
• William Ernest Keeter, III	Charlotte
Michael Doyle Killian	Waynesville
# • Richard Palmer Kitson	Wilmington, Del.
# • Larry Lee Lanning	Lexington
• William Charles Lawton	Richmond, Va.
Cecil Berry Lee	Asheboro
Raymond Otho Linker, Jr.	Charlotte
Ahmed Amin El-Maghraby	Cairo, Egypt
# • Alan Leslie Overcash	Media, Penna.
• Kendall Watson Patterson	Lynchburg, Va.
Matt John Russ	Charlotte
• Nathan Lewis Schloss	Greensboro
Joe Edmiston Sloop, Jr.	Mount Ulla
• Robert Lee Stallings, II	Owings Mills, Md.
Carl Spencer Stutts, Jr.	Salisbury
Edward Allen Turner	Gatesville
Dennis George Whitener	Lenoir

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

Thomas Coley Allen, II	Raleigh
• John Royster Armfield	Mount Airy
Henry Andrew Black, Jr.	Fayetteville
Larry Johnson Brown	Kannapolis
Phiphath Charoensawadsiri	Bangkok, Thailand
George Michael Clendenin	Wilmington
Steven Lee Coleman	Raleigh
Jonathan Ellsworth Davis	Burlington
Phillip Graham Dickerson	Zebulon
Clifton Augustus Gardner, Jr.	Nashville
William Holladay Harris	Fredericksburg, Va.
Joel David Hawkins	Weaverville
Jerry Glenn Hayes	Selma
Terry Lee Hunt	Winston-Salem
William Wesley Hunter	Siler City
Larry Maurice Johnson	Gastonia
Ruffie Allison Jones, Jr.	Clayton
Arthur King Kelly	Kinston
William Henry Kitchen	Raleigh
Gordon Saunders Lancaster	Kinston
Gary Stephan Lineback	Winston-Salem
Robert Eugene Little	Charlotte
• William Harrison Lockhart, III	Charlotte
Robert Ronald McPherson	Raleigh
Derwood Clifton Matkins	Yanceyville
Larry Stephen Matthews	Elizabeth City
Daniel Jenkins May	Hendersonville
William Clyde Mills	Mooresville
Marion David Moore	Forest City
William LeRoy Morris, Jr.	Lincolnton
John Carl Murdock, III	Troutman
Donald Lee Petty	Graham
• Douglas Lee Quinn	Wilmington
Linwood Wilson Rogers, Jr.	Wilmington
• William Frank Rosser	Sanford

• Honors •• High Honors # Honors Program † In Absentia

Edmund Vincent Rotkewicz	Cliffside Park, N. J.
Rondal Jennings Sharpe	Las Vegas, Nevada
Walter Talmadge Shermer	Winston-Salem
Dyke Wayne Starnes	Granite Falls
David Mangum Stevenson	Raleigh
Daniel Marshall Stone	Trinity
Foil David Swing, Jr.	Lexington
Travis Hocutt Tomlinson, Jr.	Raleigh
Caney Edward Tucker	Charlotte
James Elton Turlington	Clinton
Frederick Carlson Tyner	Red Springs
Gregory James Walker	Raleigh
Ralph Craig Watkins	Hickory
Thomas Edison West, Jr.	Wilmington
Howard White, III	Raleigh
John Gibson Wilson, III	Arlington, Va.

BACHELOR OF SCIENCE IN CIVIL ENGINEERING,

CONSTRUCTION OPTION

Samuel Black Bledsoe, III	Gastonia
William James Brattain	Stanfield
Olney Joseph Brown, Jr.	Salisbury
Daryl Warren Cady	Norwich, Conn.
John Eugene Daves	Asheville
Gary Hill Hodges	Whiteville
Bruce Clayton Jacobs	Leland
Leonard Franklin Jones, Jr.	Rocky Mount
John Douglas Mitchell	Wakertown
Gary Edwin Parsons	Winston-Salem
Howard Powell Redding	Asheboro
Carl Bernhard Spelbrink	Rochester, N. Y.
Rockie Davis Troxler	Elon College
Paul Colby Williams	Raleigh
Robert Glenn Wright	Arlington, Va.

BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING

William Allen Acree	Greensboro
*Thomas Davis Adams	Murphy
#**William Clay Adams, Jr.	Trenton
Charles Edward Anderson	St. Petersburg, Fla.
*Humberto Aragon	Havana, Cuba
*Walter Louis Baker, III	Burlington
#*Everette Allen Barefoot, Jr.	Erwin
Robert Clay Barker	Oxford
*George Leon Bass	Valdese
*Donald Edward Bean	Lenoir
*Grover Cleveland Bishop	Spartanburg, S. C.
James Wendelin Breitmeier	Mebane
*Gerard John Brunet	New Orleans, La.
Daniel Guy Bumgarner	N. Wilkesboro
William Carl Busching	Spring Valley, N. Y.
James Bernard Byrne	New York City, N. Y.
David Foyell Cecil	Lexington

• Honors

** High Honors

Honors Program

† In Absentia

*Richard Crafton Chambers	Winston-Salem
Alan Bruce Clark	Waynesville
Kay Nelson Clinard	High Point
*Paul Wesley Coble	Julian
# Joseph Sampson Colson, Jr.	Oxford
Paul William Denninger	Otisville, N. Y.
Danny Craig Eddleman	Kannapolis
*Bobby Lee Ferguson	Liberty
Don Ennis Freeman	Hendersonville
*Charles Elbert Fulton	Walkertown
William Bennett Hall	Pineville
Douglas Francis Hawkland, III	Timonium, Md.
Kenneth Roy Hammond	Goldsboro
Clayton Scott Hinnant	Wilson
Eugene Emmitt Holland	Franklin, Va.
Donald Wayne Hoover	Eden
# Michael Vernon Horner	Burlington
Terence Long Houghton, Sr.	Raleigh
*James Alfred Jaques, III	Memphis, Tenn.
William Michael Jarecki	Raleigh
John Andrew Jarrell	Reidsville
† Frank Kimsey Justice	Tuckasegee
*John J. Pershing Kincaid, Jr.	Reidsville
Stanley Walter King	Mount Airy
Jerry Worth Kirk	Asheville
*Seigmond Gus Kopinitz	Brigham City, Utah
Wayne John Leleux	Picayune, Miss.
*Delio Lopez, Jr.	Largo, Fla.
*James Elmore Lowe	Pfafftown
# Stephen Walter Lye	Wake Forest
Rafael Jorge Montoya	New York City, N. Y.
George Talbert Moss	Robbins
Raymond Earl Newton	Drexel
William Splane Page, Jr.	Kinston
Robert Elton Penny	Kinston
Howard Eric Poole	Glen Alpine
John Joseph Prevost	Kansas City, Mo.
Meredith Trotter Raney, Jr.	Aiken, S. C.
Thomas Prater Rankin	Lexington, Ky.
*Donald Martin Reynerson	Greenville, Texas
Roger Leon Ross	Norwood
Lawrence Eugene Rowland	Rocky Mount
Charles William Saalfrank, Jr.	Charlotte
Charles Ray Saleeby	Brevard
Robert John Schoderbek	Haw River
*Kenneth Larry Smith	South Euclid, Ohio
# Wesley Edwin Snyder, Jr.	Fayetteville
*Lawrence Oliver Stahl	Morenci, Mich.
Earley Wayne Stallard	Coeburn, Va.
*Douglas Melville Tennant	Glendale, Calif.
Robert Eugene Triplett	Grafton
Robert William Ulrich, Jr.	Sanford
Kenneth Elston Walling	Belford, N. J.

* Honors ** High Honors # Honors Program † In Absentia

John Leroy Taylor Conway

#*Joseph Harold White	High Point
*Arthur Martin Wiencken, Jr.	Statesville
**William Walter Wiles, Jr.	Burlington
Donald Roy Willett	Durham
David Lee Williams	Durham
Robert Spangling Wolf	Winston-Salem
*David Richard Wyke	Shelby
Joseph Neill York	Mount Airy
Ronald Calvin York	Charlotte

BACHELOR OF SCIENCE IN ENGINEERING MECHANICS

*Bradley Wayne Smith	Chapel Hill
Robert Stuart Steele, Jr.	Hickory

BACHELOR OF SCIENCE IN ENGINEERING OPERATIONS

Dallas Lloyd Alford, III	Rocky Mount
Jennings Blalock Almond	Albemarle
†Phillip J. Anderson	Dollar Bay, Mich.
George Eldridge Barnes	Rocky Mount
Lawrence Barnwell, Jr.	Hendersonville
James Abbott Barrow	Richmond, Va.
Franklin Wyant Bolick	Hickory
Raymond Robert Bouley	Charlotte
Joe Richard Brewer	New Salem
†Paul Latham Brinkley	Plymouth
David Jackson Brown	Mount Airy
Edward Lacey Chambers, Jr.	Danville, Va.
Gilbert Rider Chenery	Durham
Thomas Glenn Cherry	Maiden
James Rosser Collins	Raleigh
Roger Phillips Corner	Hockessin, Del.
John Edwin Couch	Durham
Norman Bowles Dennis	Durham
James Theophilus Dick, Jr.	Mebane
Philip Martin Dodson, Jr.	Riegelwood
Michael Ronald Ensley	Belmont
John Joseph Fehrenbacher	Traverse City, Mich.
Billy Fred Felton	Eure
James Geddie Fisher, II	Fayetteville
Robert Lee George, Jr.	Durham
James Capehart Gurley, III	New Bern
William Guy Hardin, III	Gastonia
†Donnie Nelson Hill	Charlotte
William Sidney Horton, Jr.	Charlotte
John Emmet Huss	Cramerton
Michael Theodore Jones	Oakland, Calif.
Curtis Stanley Kuehn	Asheville
Edward Wicker Largen	Charlotte
†Thomas Leslie Lee, Jr.	Kinston
Charles Price Loveland	Shelby
Robert Lothair Luellen	New Castle, Ind.
*Carroll Dale Merrell	Charlotte
Julius Russell Norris, Jr.	Rocky Mount

• Honors •• High Honors # Honors Program † In Absentia

Thomas Cleveland Paisley, Jr.	Toughkenamon, Penna.
Ronald Lewis Parks	Salisbury
Robert Lewis Phillips, III	Charlotte
Ronald Dale Popiel	Goldsboro
Wright Noble Rodman	Mount Olive
Henry Dean Rogers, Jr.	Greensboro
Charles Cramer Sink, II	Winston-Salem
James Abbott Swift	Shelby
Jonathan Reuben Wall Turner	Winston-Salem
Thomas Edgar Tyson	Greensboro
Donald Michael Weaver	Aberdeen
†Lawrence Edward Wicks	Akron, Ohio
James Nevit Witherspoon, II	Cherryville

BACHELOR OF SCIENCE IN FURNITURE MANUFACTURING AND MANAGEMENT

Jerry Warren Cousins	Fort Smith, Ark.
Douglas Randall Davis	Maiden
Henry Paul Fulmer, Jr.	Jackson, Miss.
William Eugene Gordon, III	High Point
•Gideon Conway Huddle	Martinsville, Va.
Ronald Steven Killian	Hickory
••Lonnie Lee Miller, III	Salisbury
David Milton Moore	Hickory
Thomas Alexander Scott, Jr.	Lenoir
†William Dennis Zapke	Bon Air, Va.

BACHELOR OF SCIENCE IN GEOLOGICAL ENGINEERING

David William Austin	High Point
James Wadsworth Heller, Jr.	Fayetteville
#••Lewis Edwin Link, Jr.	Easton, Penna.
•Franklin Jay Phillips	Dover, Del.
Robert Melvin Whisnant	Lenoir

BACHELOR OF SCIENCE IN INDUSTRIAL ENGINEERING

Alton Byron Bizzell	Newton Grove
•Larry Banks Blackwood	Greensboro
•Robert Arthur Boyette	Fayetteville
Morris O'Neal Bumgarner	Granite Falls
Mayo Elisah Collier, Jr.	Kenly
David Marion Crews	Stoneville
†David Joseph DuMontier	Charlotte
Donnie Russell Faucette	Kenly
William Albert Griswold	Raleigh
William Stephen Head	Winston-Salem
Harvey Eugene Jenkins	Cramerton
Clyde Alden Kaschub	Gastonia
••Ronald Ladd Kendrick	Gastonia
Kenneth Wayne Lawing	Maiden
Robert Wade Lindsay, Jr.	Enka
John Eddleman Mack, III	Gastonia
Anthony Arms Monfrado	Spindale
••David Franklin Parker	Rocky Mount
Thomas Robert Petrosino	New Haven, Conn.

• Honors •• High Honors # Honors Program † In Absentia

Prakash Babulal Sheth	Ahmedabad, India
Richard Alan Smith	Asheville
Max Alberto Soto	San Jose, Costa Rica

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

Eugene Stanley Adams	Greensboro
*Horace Roland Ashburn	Charlotte
*Paul Lawrence Bailey	Roxboro
*Wayne Boyd Baker	Hickory
Leonard Bruce Barnwell	Hendersonville
William David Bibb	Fayetteville
#*Thomas Furman Brooks	Charlotte
Paul Ernest Bruchon, Jr.	Gastonia
Ronald Michael Callan	Falls Church, Va.
Clay Hughes Cline, Jr.	Boonville
Jimmy Monroe Corriher	China Grove
Ernest Clark Dowless	China Grove
Johnny Emerson Ellington	Graham
John Robert Field	Kannapolis
Harold Eugene Garver	China Grove
George Georgopoulos	Athens, Greece
Thomas Francis Gormley, Jr.	Union, N. J.
Frederick Raymond Greenwood	Cary
Jan Hagers	Westfield, N. J.
Edgar Milton Harris, Jr.	New London
Rudy Wayne Herren	Candler
Luther Wright Horne, III	Pleasant Garden
Charles Edward Hughes	Greensboro
William Thomas Johnson	Madison
Richard Paul Joseph	New Bern
Graham Harlee Kenan	Wilmington
*William Sease Koon	Asheville
Bruce Wayne Kyles	Maiden
James MacRae Lamb, Jr.	Kinston
*James Michael Larsen	Severna Park, Md.
Joseph Edwin Leonard	Greensboro
#*Charles Gerald Letchworth	Rocky Mount
Charles Joseph McCann, Jr.	Rockville, Md.
Edward Mallory McLean	Columbia, S. C.
Bennie Franklin Mangum	Angier
Thomas Edward May	Springfield, Va.
Lowell Thomas Miller	Sparta
Sidney Cole Mitchell	Denton
William Thomas Mitchell, Jr.	Kinston
Willard Milton Moore, Jr.	Asheville
Ronald David Norman	Charlotte
Spencer Wakefield O'Meara	Charlotte
James Blair Phillips	Bridgeton
Roy Norman Ray	Burnsville
Robert Hart Raynor	Henderson
Daniel Milas Ritchie, Jr.	Concord
James Dwight Royall	Thurmond
*Ferry Lee Seaford	Concord
*Barry William Story	Lenoir
Fred Dean Upchurch	Charlotte
Kenneth Michael Wallace	Durham

* Honors ** High Honors # Honors Program † In Absentia

BACHELOR OF SCIENCE IN METALLURGICAL ENGINEERING

Roger Edwin Cantrell	Gastonia
Gerald Mills Cobb	Hampton, Va.
Joseph Eugene Cresswell, Jr.	Badin
Carl Dennis Honeycutt	Gastonia
William Thomas Langendorfer	Sidney, N. Y.
# Michael Kent Lee	Monroe
Joseph McCracken Marr	Asheville
* Milton Warner Milner	Asheville
* Harold Edwin Oliver	Winston-Salem
Robert Patrick Steinmetz	Oradell, N. J.
Joseph Reed Thompson	Chapel Hill
Eric Smaltz Vogel	Arlington, Va.

BACHELOR OF SCIENCE IN NUCLEAR ENGINEERING

John Raymond Concklin	Pomona, N. Y.
* Charles Burch Davis, III	Roxboro
* Richard James Hosey	Raleigh
Cyrus Bryan Israel	McCain
Elmo Becton James	Everetts
Frank Harold McDougall	Pompano Beach, Fla.
Johnny McGrady	North Wilkesboro
Robert James Veklotz	Angola, N. Y.

School of Forest Resources



BACHELOR OF SCIENCE IN FORESTRY

Aubrey Sidney Baynes	Wendell
Stanley Walker Bingham	Clemmons
† Terry Hilliard Brookshire	Enka
* Albert Banner Coffey	Blowing Rock
Charles Turney Foster	Charlottesville, Va.
* George Graham Glass, Jr.	Raleigh
Harold Glenn Grady	Goldsboro
Gary Hale	Tyner, Ky.
James Victor Henderson	Saltville, Va.
James Thomas Jennings	Raleigh
Peter Lent Johnston	Burlington
Larry Martin Kennedy	Altoona, Penna.
David Aaron Noll	Norristown, Penna.

• Honors •• High Honors # Honors Program † In Absentia

Allen Louis Plaster	Morganton
*Henry Donnell Smith	Peachland
Harvey Allen Wade	Winston-Salem
James Hamilton Ware, Jr.	Turkey
*Michael Lynn Weatherford	Clinton, Ky.

BACHELOR OF SCIENCE IN PULP AND PAPER TECHNOLOGY

*David Lee Ashcraft	Pine Bluff, Ark.
**Mack William Bailey	Andrews, S. C.
*Joseph Wilder Boggs	Rome, Ga.
Leslie Allison Britton	Plymouth
Gale Herbert Goodman	West Jefferson
Jack Eugene Holder	Gaffney, S. C.
Andrew Louis Johnson	Oak City
Lawrence Julius Johnson	Georgetown, S. C.
*George Edward Lennon	Bladenboro
*Charles Edwin McLemore	Crossett, Ark.
John Francis Prichard	Salisbury
*Johnnie Dupree Respass	Plymouth
Harold Edward Sellers	Elyria, Ohio
*Michael Edward Ward	Neva, Tenn.
*David Eugene Zukowski	Erie, Penna.

BACHELOR OF SCIENCE IN RECREATION AND PARK ADMINISTRATION

Robin Dana Andrews	Raleigh
Anthony Patrick Barchuk	Brooklyn, N. Y.
Edward Joseph Biedenbach	Pittsburgh, Penna.
Thomas Larry Bradford	Fayetteville
James Joseph Davis	Manor, Penna.
† John William Douglass	Pittsburgh, Penna.
Joe Randolph Franklin	West Jefferson
Mary Ella Garriß	Raleigh
David Clark Hobson	Dunn
*Walter Phillip Kanoy	Thomasville
John Stuart Lawrance	Springfield, Penna.
*Barry Charles Lock	Belvidere, N. J.
David Charles Munhall	Hopkins, Minn.
James Lee Osborne	Hampton, Va.
Robert Eugene Parries	Mount Airy
Joel Eugene Peterson	Raleigh
*George Edward Rollins	Raleigh
*Robert Scott Stokes	Haddonfield, N. J.
Edward Richard Sykes, III	Wendell
Joseph Speed Jones Tanner	Palmer Springs, Va.
Joseph Cornelius Taylor	Raleigh
John Howard White	Orlando, Fla.
Robert Lee Williams, Jr.	New Bern

BACHELOR OF SCIENCE IN WOOD TECHNOLOGY

†*Marcel Decelles	Quebec, Canada
Marc Francis Frampton	Pequannock, N. J.
Andrew Stewart Nuckols	Rocky Mount

* Honors ** High Honors # Honors Program † In Absentia

Robert Earl Nye	Clarkton
†Charles MacKarsie Page	Alexandria, Va.
Kimball Wyeth Russell	Badin
†John Frederick Schneider	Hammond, La.
Frank Roger VanNote	Ashbury Park, N. J.
Michael Carl Wiemann	Montvale, N. J.

School of Liberal Arts



BACHELOR OF ARTS

†Zeno Richard Allen	Winterville
Salvatore Dominic Amendolia	North Bellmore, N. Y.
••Gayle Maxene Andrews	Emmaus, Penna.
••Thomas Michael Antone	Raleigh
Henry Paul Averette, Jr.	Raleigh
Harry Strong Baker, III	Charlotte
Frank Fleetwood Bateman, Jr.	Charlotte
Joseph Arnold Brake	Rocky Mount
Edward Earl Braswell	Rocky Mount
•Kenneth George Burlock, Jr.	Jacksonville
••Mary Anne Burton	Raleigh
Ralph Tyrone Campbell	Raleigh
John Fulghum Cannady, III	Henderson
•Charles Gerald Carpenter	Elkin
Martin Bruce Chadwick	Raleigh
•James Stephen Chiles	Baltimore, Md.
Daniel Atlas Cockman	Robbins
Charles David Collins, Jr.	Zebulon
Elizabeth Powell Conrad	Fuquay-Varina
Samuel Edward Cope	Winston-Salem
•Dennis Laurence Cuddy	Raleigh
John Thomson Dawson, Jr.	Winston-Salem
Gloria Holmes Dean	Franklinton
Edgar Ray Denny	Carthage
†Melvin Joseph Doyle	Zebulon
••John Fortune Dunn	Sylva
Gian Carlo Brunetti Duri	Rome, Italy
•Harold Charles Dyer, Jr.	Wendell

• Honors

•• High Honors

Honors Program

† In Absentia


Robert Walter Eager	Upper Montclair, N. J.
†Jayne Ellen El-Ackad	New Brunswick, N. J.
*Charles Thomas Ferebee	New Bern
••Edward William Fisk	North Rose, N. Y.
Jane Creel Fox	Cary
Donna Marie McFarland French	Reidsville
Geoffrey Terrence Gaede	Durham
William Francis Gallogly, Jr.	Arlington, Va.
Gerald Fredric Gallup	Raleigh
*Charles John Gantner, Jr.	Piscataway, N. J.
Robert James Garner	Raleigh
Richard Arthur Gay	Raleigh
Ronald Glenn Goodman	Rockingham
*Ann Baggett Goodnight	Fayetteville
••Nettie Bess Hair	Fayetteville
David Earl Hale	New Bern
*Sulo Herman Heikkinen	Fayetteville
Stephen Henry Horney	Raleigh
Linda Alethea Howell	Raleigh
Robert Caldwell Hudspeth	Winston-Salem
Harry Steven Hughes	Thomasville
Jean Tilden Jackson	Wilmington
Timothy Hawley Johnson	Marion
William Francis Jones	Annapolis, Md.
William H. Jones, III	Saratoga
Henry Filmore Kale, Jr.	Mount Holly
Gerry Diane Katz	Statesville
David James Kennedy	Thomasville
Geary Kent	Yadkinville
Reinhardt Joseph Kieffer	Fayetteville
Byron Nelson Kimball	Winston-Salem
Stephen Paul King	Raleigh
*Bettye Kay Easley Kirk	Natchitoches, La.
†William Bryan Kluttz, Jr.	Salisbury
George Walter Knight	Rockingham
†William Throsby Kretzer	Springfield, N. J.
Raymond Arthur Lamont	Richmond, Va.
Hazen Glenn Lancaster, Jr.	Windsor
*Peggy Lynn Lassiter	Raleigh
*Dale Edward Lichtblau	York, Penna.
James Kelly Lockhart	Aiken, S. C.
Milford Holmes McCrary, Jr.	North Charleston, S. C.
†Leon Ronald McLawhorn	Kinston
*Jenette O'Keefe Maloney	Winston-Salem
Mary Elizabeth March	Raleigh
*George Everett Marsh	Los Angeles, Calif.
Sharon Cooke Marshburn	Wendell
*Andrea Mewborn Montague	Raleigh
†Christopher James Monteleon, Jr.	Raleigh
*Joan Taylor Munger	Raleigh
Roland Berg Newhouse, Jr.	Raleigh
*Mary Katherine Newton	Forest City
†Joseph Edward Nicholson, Jr.	Raleigh

• Honors

•• High Honors

Honors Program

† In Absentia

Robert Hugh Noland	Waynesville
Jerry Warren Norris	Jamesville
Ness Olsen	Memphis, Tenn.
••Julian Eugene Parker, Jr.	Raleigh
Joseph Robert Personette	Vienna, Va.
Robert Jackson Pickard, Jr.	Greensboro
Vickie Lou Pollock	Snow Hill
••Rodney Ponder Poole	Raleigh
Michael Brian Prone	Scituate, Mass.
Larry Restivo	Bloomfield, N. J.
•Mary Seibel Richardson	Chapel Hill
Wesley Talbert Satterwhite	Louisburg
Quincy Jackson Scarborough, Jr.	Fayetteville
Thomas Vance Setzer	Raleigh
Richard Shackelford	Wake Forest
Stephen Cowles Shepherd	Ferguson
†Ross Minish Sigmon, III	Burlington
•Norman Jerry Simonoff	Norfolk, Va.
Barbara Sellers Smith	Raleigh
•Karen Maxine Smith	Mocksville
†Joseph Wilton Stainback	Henderson
Alfred John Steinberger, III	Charlotte
Joan Alexander Stenhouse	Charlotte
•Virginia Cagle Stephanakis	Concord
Odes Lawrence Stroupe, Jr.	Crossnore
†Leslie Dwain William Strumfels	Winston-Salem
†Lyle Parke Thomas	Raleigh
Dick Johnson Thompson	Raleigh
Mark Robert Thompson	Decatur, Ga.
Edwin Gilbert Thurlow, Jr.	Raleigh
★  Franklin Waters Trapnell, Jr.	Baltimore, Md.
Robert Chung Kwong Tsang	Hong Kong
John Robert Urban	Raleigh
•Bettina Lee Warthen	Raleigh
•Mary Ann Weathers	Raleigh
•John Elwood Webb	Cary
James Michael Weeks	Raleigh
†Elizabeth Brewer Weidhuner	Raleigh
William Henry White	Raleigh
William Wallace White, Jr.	Black Mountain
†Nikki Catherine Wiesley	Winston-Salem
Bascombe Jay Wilson	Asheville
Stephen Michael Wilson	Newton
Karen Daye Wolff	Durham
Donald Roger Woolard	Washington
•Donald Edwin Wynne	Wake Forest
Mahmoud Zanjani	Tehran, Iran

BACHELOR OF SCIENCE

†Robert Steve Jolley	Cliffside
Ahmed Amin El-Maghraby	Cairo, Egypt
Gary Steven Smithwick	Raleigh

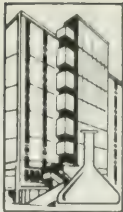
• Honors

•• High Honors

Honors Program

† In Absentia

School of Physical Sciences and Applied Mathematics



BACHELOR OF SCIENCE IN APPLIED MATHEMATICS

Herbert Lee Benoy, III	Hamlet
#••Robert Emil Botsch	Lexington
*Dennis Lee Carroll	Charlotte
†Gerald Kay Dowlin	St. Pauls
*Robert Edward Dungan	Kingsport, Tenn.
*Gary Richard Feimster	China Grove
*Arthur Lewis Frazier, Jr.	Charlotte
Howard Wayne Gerringer, Jr.	Albany, Ga.
Robert Alson Gary <i>Gray</i>	High Point
Noel Reed Hartsell	Albemarle
*Donald Lee Hill	Ararat
*William Frederick Horton, Jr.	Raleigh
Charles Marc Hubbard	Lillington
Robert Gordon Jones	Greenville, S. C.
*William Erwin Linn, Jr.	Fayetteville
William Henry Lucas	Raleigh
*James Donald McAdams	Mebane
Lynn Gray Maddry, Jr.	Raleigh
Janice Eloise Malone	Williamston
Rickie Lawrence Manuel	Draper
#Michael Eugene Mauney	Charlotte
Carolyn Andrea Newhouse	Raleigh
*Marvin Ray Oliver	Kinston
Donald Harold Plake	Winston-Salem
Franklin Russell Rhue	Raleigh
Henry Horton Robinson, II	Greensboro
William Bennett Thaler	Manassas, Va.
Jack Lawrence Touchstone, Jr.	Greensboro
Donald Wilson Turner	Raleigh
*Karan Melinda Tuttle	Virginia Beach, Va.
#••Charles Jackson Washam, III	Charlotte

BACHELOR OF SCIENCE IN CHEMISTRY

Joseph Thomas Blackwell, III	Brevard
Samuel William Clary	Lawrenceville, Va.
Wayne Allen Cline	Charlotte
Donald Wayne Horne	Autryville

BACHELOR OF SCIENCE IN EXPERIMENTAL STATISTICS

<i>Michael Ross Austin</i>	<i>Marshallville</i>
Wilson Chiu Shiang Chen	Hong Kong
Bartlett Bowers Lewis	Asheville

• Honors •• High Honors # Honors Program † In Absentia

BACHELOR OF SCIENCE IN PHYSICS

#••Ted Roy Clem	Golden Valley, Minn.
•Lawrence Arthur Culler	High Point
Davis Eastland Hays	Kinston
•William Gerald Johnson	North Wilkesboro
Paul Warner Kivett	Greensboro
Nicholas George Koutroulias	Charlotte
#David Benjamin Montgomery	High Point
#Thomas Lee Murdock	Silver Spring, Md.
Nancy Green Robbins	Candler
•John Francis Seely	Raleigh
•Horace Brantley Snyder	Sylva
Robert Beard Teese	Leesburg, Fla.
#Paul William Tillman, Jr.	Raleigh
Harold Stephen Zimmerman	Winston-Salem

School of Textiles



BACHELOR OF SCIENCE IN TEXTILE CHEMISTRY

Edward Basinger	Spencer
Larry Allen Baynes	Reidsville
••Michael Wayne Bernhardt	Salisbury
Larry Edward Blackburn	Pfafftown
•John Hao-Kiang Chan	Naha, Okinawa
David Kemp Covington	Rural Hall
Robert Edward Dalton	Raleigh
Robert Petre Daniels, Jr.	Elizabeth City
Bruce Andress Griffith	Woolwine, Va.
Claude Edwin Hamilton, Jr.	Salisbury
Johnny Antoine Handal	Port-au-Prince, Haiti
••Stephen William Hebert	Raleigh
•Sylvia Wai-Chu Ho	Hong Kong
Robert Barney Hull, Jr.	Gastonia
Frederick Palmer Isley, Jr.	Graham
Benjamin Plato Jenkins, III	Asheboro
Robert Clark Kearns	Pleasant Garden
Francis Pak-Hang Lau	Hong Kong
•Clayton Minto Legault	Ontario, Canada

• Honors •• High Honors # Honors Program † In Absentia

Charles Max Miller, III	Salisbury
*Real Joseph Erne Morin	Quebec, Canada
†Pierre Perreault	Montreal, Canada
Jerry Harold Reitzel	Liberty
Everette Eugene Shaver, Jr.	Salisbury
*James Roche Simpson	Concord
*Frederic Lewis Smyre, III	Gastonia
David Walter Tarlton, Jr.	Mount Pleasant
*Larry Clifton Wadsworth	Smithfield
*William Thomas Warden	Elizabeth City
Harvey Lee Wicker	Sanford
Gerald Lynn Williamson	Kinston
Joseph Brian Wilson	Durham
*Leonard William Wood	Arlington, Va.

BACHELOR OF SCIENCE IN TEXTILE TECHNOLOGY

Wesley Thaddeus Adams, III	Raleigh
Bruce Forsyth Allen	Greensboro
Robert Gary Allen	Champlain, Va.
Larry Michael Alley	Kernersville
Roy Lawrence Anderson	Harmony
Frank Bradley Beal	Lincolnton
Steve Allen Bolick	Hickory
*John Frank Bowers	Norwood
Paul Henry Brannock	Kernersville
William Orville Caldwell, Jr.	Clyde
Louie Grayson Carter	Winston-Salem
*Billy Chow Lui Chow	Hong Kong
John Elbert Collier	Whiteville
Clifton Wayne Cook	Winston-Salem
Roy Hayes Cox, Jr.	Charlotte
Danny Rane Dampier	Morrisville
Jimmy Marshall Dellinger	Hickory
Stephen Glenn Dobbins, Jr.	Elkin
Terry Glenn Everhart	Lexington
Peter Anthony Falter	Caracas, Venezuela
*Grady Joe Frick	Albemarle
Richard Lee Gambill	Eden
Willard Chester Garner	Morehead City
Henry Baxter Gibson, Jr.	Whiteville
Nicholas Keith Gilbert	Newton
James S. Gilliam, III	High Point
*Jay Elliot Ginsburg	Great Neck, N. Y.
Jerry Wayne Goodman	Shelby
David Lee Gordon	Winston-Salem
Ottis Lee Gordon, Jr.	Monticello
Jackie Harold Grissom	Jamestown
John Millard Groet	Grifton
*Robert James Grubbs	Jacksonville
*John Nance Hall	Elkin
Harry Lester Hancock	Kannapolis
*William Chester Henderson	Newton
Amos Jackson Hough, Jr.	Wingate
Michael McKenzie Howle	Burlington
Charles Eugene Ipock	Vanceboro

* Honors ** High Honors # Honors Program † In Absentia

Robert Chapman Jackson	Grifton
•Richard Erik Jenkins	Concord
Albert Ernest Johnson	Sanford
•Charles Senter Johnson, Jr.	Marion
Joseph William Kernodle	Reidsville
†Patrick Roy Duffern Leverington	Ontario, Canada
James Reid Lewis	Gastonia
Ronald Mack Liffman	Bayside Hills, N. Y.
•Charles Patterson Logan, Jr.	Mooresboro
Roy Leon Lynam	Wake Forest
Daniel Lauchlan McLaurin, III	Rowland
•Randy Johnson McSwain	Shelby
Mohamed Loutfy Mansour	Alexandria, Egypt
Dwane Russell Mitchiner	Garner
Richard LeMoyné Morgan	Roanoke Rapids
Murry Walter Munns, Jr.	Wilmington
Michael Robinson Neaves	Elkin
Walter Leon Overman	Rocky Mount
James Wilson Owens	Elizabeth City
Leslie Ray Payne	Mebane
Leigh Brickhouse Peele	Columbia, S. C.
Thomas Carey Phillips	Edenton
Roy Eugene Pierce, Jr.	Vaughan
David Timothy Rouse	LaGrange
Julian Council Shaw, Jr.	Bladenboro
William Williams Shaw	Wilmington
Robert Allen Shinn	China Grove
Richard Wayne Summerlin	Albemarle
Bobby Wayne Taylor	Rocky Mount
Richard Jay Thal	Longmeadow, Mass.
Moises Urman	Lima, Peru
Randall Lee Ward	Durham
•Steve Franklin Warren	Lincolnton
James Stephen Weathersbee	Norwood
Charles Timothy Weaver	Goldsboro
Thomas Edward Weybrew	Raleigh
Claude Abbott Whitehurst	Elizabeth City
Ernest Ervin Whitener	Hickory
•Walter Howard Wilkinson, Jr.	Hickory
Zeno Russell Windley, Jr.	Spring Hope

Professional Degrees



Civil Engineer, Structural Option

†Donald Dietrich Haigh Statesville

• Honors •• High Honors # Honors Program † In Absentia

Civil Engineer, Transportation Option

Fredy Jesus Santamaria Caracas, Venezuela

Electrical Engineer

William Carl Busching Spring Valley, N. Y.
William Woollcott Ellington, Jr. Raleigh
James Alfred Jaques, III Memphis, Tenn.

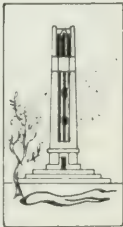
Industrial Engineer

Tony Bryon McNeill West Jefferson

Nuclear Engineer

†Maurice Daniel McIntosh Charlotte
Benjamin Ralph Sylvia Ashland, Va.

Masters Degrees



MASTER OF AGRICULTURE

Patricia Ann Kelly Greensboro
Robert Wayne Swain Southport

MASTER OF APPLIED MATHEMATICS

Sidney Bonitz Andrews, Jr. Wilmington
Jack Peter Bujalski Crosby, N. D.
†William Ferrell Burch, III Newport News, Va.
†John Paul Cerak Clayton, N. J.
†Gerald Wayne Corwin Orlando, Fla.
†Paul Harry Dimmick, Jr. Rawlins, Wyo.
Howard Jackson Fry, Jr. Riverside, Calif.
Joseph Parke Gaston, Jr. Greenville
Rebecca Miller Howard Raleigh
James Allison Hubbard Hope Mills
Peter Lawrence Knepell Kew Gardens, N. Y.
Derek Alan Lindsley Asheville
†William Blanchard Lowe, Jr. Auburn, Ala.
Johnny Truite Lowman Valdese
Gerald Arnold Marin High Point

• Honors •• High Honors # Honors Program † In Absentia

†Shirley Libbie Saleeby	Wilson
†Jeffrey Edward Schofield	Columbus, Ohio
Isham Creston Shields, Jr.	Columbia, S. C.
William Wallace Taylor	Corpus Christi, Texas

MASTER OF BOTANY

†James Richard Goodwin	Reedley, Calif.
Tommy Rockwell Miller	Conover

MASTER OF ECONOMICS

†Fahd Muhammad Bunyan	Al-Hasa, Saudi, Arabia
Katherine Merritt Chambers	Lumberton
Charles Thomas Gurkin, Jr.	Plymouth
Joel David Hill	Carolina Beach
Waldo Clyde Jones, Jr.	Raleigh
Paul Cecil Kirby	Raleigh
†William Cleland Lowe	Raleigh
Dimitrios Christos Papacosmas	Kleidion-Arta, Greece
†William Rossiter Peabody	Raleigh
William Vogler White	Winston-Salem

MASTER OF EDUCATION

Adult Education

David Horton Bland	Troy
James Gary Futrell	Tarboro
Murray Lane Goodwin	Columbia
Milton Carroll Harding	Kenbridge, Va.
Horace Jefferson Hux	Reidsville
Nancy Bush Preas	Leaksville
Hilda Grace Scott	Buckhannon, W. Va.
Beverly Annette Shippe	Lost City, W. Va.
Jefferson Woodrow Upchurch, Jr.	Garner

Agricultural Education

William Howard Adams, Jr.	Maiden
William Alton Ballance	Fremont
Larry Thomas Beckham	Henderson
Jesse Roland Butts	Oxford
Curtis Eugene Callihan	Elizabethtown
Roosevelt Carttret	Nakina
Walter Allan Edwards	Asheboro
William Wayne Franklin	Lumberton
Benny Bryant Hampton	Asheboro
Chester Bryant Honeycutt	Burlington
Coy Lynn Hudson	Concord
Charles Elliott Johnson	Greenville
Charles Little Keels	Monroe
Thomas Stephenson Keith	Fuquay-Varina
James Hector Langdon, Jr.	Benson
Robert Kenneth Melvin	Rockingham
Nicholas Larus Paul	Raleigh
†Benjamin Graham Potter	New Bern
Larry Edward Tetterton	Louisburg
Benjamin Griffin Ware	Newland
Robert Davis Warren	Benson

• Honors •• High Honors # Honors Program † In Absentia

Guidance and Personnel Services

†Sandra Nelson Arthur	Jacksonville
†Alonzo Merrick Barnes, Jr.	Philadelphia, Penna.
Roderick Wilson Bradley	Marion
†Sara Meister Buchanan	Bartlesville, Okla.
Thomas Leak Covington, Jr.	Davidson
Landrum Lee Cross	Raleigh
Nancy McLaurin Shannon Drew	Marietta, Ga.
Thomas Harold Elder	Fayetteville
†Stanley Melvin Epstein	Philadelphia, Penna.
Florence Irving Francis	Raleigh
Norma J. Bussman Grauer	Raleigh
Billy Ray Johnson	Dunn
†Clarence Jones	Bradenton, Fla.
Rosemary McKay Jones	Garner
†James Carl Keylon	Enka
Judith Allred Kinney	Winston-Salem
†Shelby Harris Mansfield	Camden
Diane Ullman Marshall	Durham
Gene Heafner Moore	Raleigh
†Mary Elizabeth Goforth Parker	Raleigh
Linwood Warren Powell	Lawrenceville, Va.
†Jesse Allan Proctor	Shelby
Elizabeth Rank Smaltz	Wood, Penna.
Harriette Hudson Smith	Raleigh
Emerle Franklin Stephenson, Jr.	Murfreesboro
Ronald Gilbert Weaver	Buchtel, Ohio
Ruth Boaz Williard	High Point

Vocational Industrial Education

Kenneth Shuford Herman, Jr.	Raleigh
Richard Lee Waldroup, Jr.	Draper

MASTER OF ELECTRICAL ENGINEERING

†Lyles Cornwell Adair	Clinton, S. C.
William Leon Avery	Winston-Salem
Grover Cleveland Bishop	Spartanburg, S. C.
†Jack Roger Bridges	Raleigh
Gerard John Brunet	New Orleans, La.
Samuel Grady Burgess	Hamptonville
Kun Ti Chen	Taipei, Taiwan
William Carl Drake	Cary
Jerry Sanders Harris	Cary
†Kong-Ho Huang	Ho-Mei, Chang-Hua, Taiwan
Alec Jablonover	Haifa, Israel
Seigmond Gus Kopnitz	Brigham City, Utah
Delio Lopez, Jr.	Largo, Fla.
Charles Kennett McAdams, Jr.	Fayetteville
Roy Donald Raper	Wilson
Donald Martin Reynerson	Greenville, Texas
†William Clarence Ritz	McKeesport, Penna.
Edward Benjamin Taylor	Fayetteville
Douglas Melville Tennant	Glendale, Calif.
†Mac Morgan Wisler	Southern Pines

• Honors ** High Honors # Honors Program † In Absentia

MASTER OF EXPERIMENTAL STATISTICS

Romulo Quintos Bengson	Manila, Philippines
Krissana Bhotvcharoen	Pitsanuloke, Thailand
Aporn Chowadee	Bangkok, Thailand
James Howard Goodnight	Wilmington
John Marshall Lounsbury	Decatur, Ga.
Cheng-Hsuan Yuan	Taiwan, China
Chomnit Yudhanahas	Bangkok, Thailand

MASTER OF FORESTRY

Shah Ali Imam	Khulna, East Pakistan
Herbert Julien Kirk	Aberdeen
†Richard Vanneman Welch	Greensboro

MASTER OF MECHANICAL ENGINEERING

Kuen-Wen Chang	Kaohsiung, Formosa
George Benjamin Cox, Jr.	Durham
†Leroy Allen Farr	Great Bend, Kansas
†Charles Frederick Greer	Hopkinsville, Ky.
Jerry Ned Hefner	Norfolk, Va.
Earle Knowlen Huckins, III	Newport News, Va.
†John Paul Lay	Baton Rouge, La.
Chun Cheng Lii	Taichung, Taiwan
Li-Hsiung Liu	Chia-Yi, Taiwan
Ralph Norman McGill	Charlotte
Michael Grant Miller	Charlotte
†Harvey Lee Scholz	San Antonio, Texas
Zan Prevost Smith	Chapel Hill
†James Lowell Yarborough	Shelby
†Tom Shyh-Jyh Yu	Taipei, Taiwan

MASTER OF WOOD TECHNOLOGY

Ronald Marion Bienias	Chicago, Ill.
-----------------------------	---------------

MASTER OF ARTS

Economics

James Howe Johnson, Jr.	West Point, Va.
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MASTER OF SCIENCE

Adult Education

Joseph Conrad Glass, Jr.	Raleigh
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Agricultural Economics

†Vittorio Santaniello	Bari, Italy
-----------------------------	-------------

* Honors

** High Honors

Honors Program

† In Absentia

Animal Science

†Grover Washington Westmoreland Hendersonville

Botany

†Gary Spencer Hartshorn New Egypt, N. J.
John Charles Nemeth Chicago, Ill.

Chemical Engineering

Narong Chandr-Ruang-Phen Bangkok, Thailand
†James Wayland Eheart Silver Spring, Md.

Chemistry

†Edward Covington Rhea Old Hickory, Tenn.

Civil Engineering

†Raymond Richard Avent, Jr. Newport News, Va.
†Timothy Gayle Broome Monroe
Clyde Dale Buckner Chapel Hill
†Charles Thomas Cochrane High Point
Sabir Hasan Mubarak Dahir Raleigh
†Richard McCallum Jackson Henderson
David Guy Modlin, Jr. Williamston

Crop Science

†Roy Walton Mozingo Princeton
Johnny Calvin Wynne Williamston

Engineering Mechanics

Herbert Martin Eckerlin Raleigh
Gayle Madison Wylie Cary

Entomology

James Robert Baker Apex

Food Science

Michael Maynard Peebles Constableville, N. Y.
Dale Lee Scheusner Clear Lake, S. D.
Dennis Charles Westhoff Afton, N. Y.

Genetics

Stanton Fred Hoegerman Brooklyn, N. Y.
†Eiji Shimura Hiratsuka, Kanagawa, Japan

Horticultural Science

†Luis Guillermo Guillen Arequipa, Peru
George Roscoe Hughes Raleigh

• Honors •• High Honors # Honors Program † In Absentia

Industrial Engineering

William Lowell Hanna	Lewiston, Mich
†Rameshchandra Purshottam Kakad	Kakira, Uganda
†Ernest William Moore, Jr.	Raleigh

Mechanical Engineering

Bobby Lee Berrier	China Grove
Harry Loyd Morgan, Jr.	Portsmouth, Va.
Padmakar Madhav Niskeode	Hyderabad, India
†Abdul Manan Rahmani	Ramak, Ghazni
†Pablo Francisco Schick	Caracas, Venezuela
†Dipak Manilal Shah	Bombay, India
Priyadarshi Ratanlal Sheth	Baroda, India
†Benjamin Ju-Cheng Wu	China

Microbiology

†Willard Troy Blevins	North Wilkesboro
†Kenneth Roland Dunlap, Jr.	Portsmouth, N. H.

Nuclear Engineering

†Gordon Randel Bond	Bluefield, W. Va.
†Hiroshi Matsumura	Raleigh

Physics

†Chetna Amritlal Shah	Bombay, India
-----------------------------	---------------

Science Education

†Robert Charles Evans, Jr.	Hazelwood
Merrill Thomas McColl	Ballston Lake, N. Y.
William Carl Smith	Meadville, Penna.

Soil Science

†Jimmy Douglas Gregory	Dudley
------------------------------	--------

Textile Chemistry

Howard Allen Chamberlain	Raleigh
Jerome Hardy Rhodes	Raleigh

Textile Technology

Ralph Delano Elliott	Warsaw, Va.
Charles William Reed	Winston-Salem
Frederic Lewis Smyre, III	Gastonia

Zoology

Fred Willie Beckerdite, Jr.	Winston-Salem
Richard Bache Hamilton	Raleigh

• Honors •• High Honors # Honors Program † In Absentia

Doctor of Education Degrees

Samuel Bruce Petteway, Adult Education
Kinston, North Carolina

Dissertation: A Comparison of College Resident and Commuter Students on Selected Psycho-Sociological Characteristics. (Under the direction of Edgar J. Boone).

Dwight Carroll Rhyne, Adult Education
Chapel Hill, North Carolina

Dissertation: Attitude Set, Group Learning, and Attitude Change. (Under the direction of Robert John Dolan).

Doctor of Philosophy Degrees

Mumtaz Ahmad, Crop Science
Peshawar, Pakistan

Dissertation: Inheritance of Ear Height in *Zea mays* L. (Under the direction of Donald Loraine Thompson).

†Mohammed Omar Ali, Wood Technology
Chittagong, East Pakistan

Dissertation: Strength-Chemical Composition Relationships of Yellow-Poplar (*Liriodendron Tulipifera* L.). (Under the direction of Aldos Cortez Barefoot, Jr.).

Joseph Patrick Archie, Jr., Engineering Mechanics
Kinston, North Carolina

Dissertation: An Analysis of the Contribution of Alveolar Surface Properties to the Mechanics of Respiration. (Under the direction of Patrick Hill McDonald).

†Ivan Raul Balconi, Animal Science
Guatemala, Central America

Dissertation: Studies on the Intestinal Absorption and Blood Clearance of Lactic Dehydrogenase Isoenzymes. (Under the direction of James G. Lecce).

†Samuel Russell Bland, Applied Mathematics
Yorktown, Virginia

Dissertation: The Two-Dimensional Oscillating Airfoil in a Wind Tunnel in Subsonic Compressible Flow. (Under the direction of Ernest Edmund Burniston).

Garnett Lowell Bradford, Economics
Cynthiana, Kentucky

Dissertation: An Economic Analysis of the Costs of Producing Flue-Cured Tobacco and Cost-Production Variable Relationships. (Under the direction of William Douglas Toussaint).

James McLure Bradford, Jr., Mechanical Engineering
Newport News, Virginia

Dissertation: A Study of the Adhesion of Nickel. (Under the direction of Frederick Otto Smetana).

† In Absentia

- †Peter John Burfening, Animal Science
Raleigh, North Carolina
- Dissertation: Investigations into Causes of Subsequent Embryonic Death in Mammalian Ova Fertilized by Heat-Stressed Spermatozoa. (Under the direction of Lester Curtis Ulberg).
- Yi-Chang Chiu, Entomology
Chiayi, Taiwan
- Dissertation: Affinity and Phosphorylation Constants for the Inhibition of Acetylcholinesterase by Malaoxon, Acetoxon and Related Organophosphates. (Under the direction of Walter Carl Dauterman and Frank Edwin Guthrie).
- Thomas Berry Cobb, Physics
Atlanta, Georgia
- Dissertation: High Resolution Nuclear Magnetic Resonance of Polycyclic Aromatic Hydrocarbons and Aromatic Heterocyclic Compounds. (Under the direction of Jasper D. Memory).
- †Timothy Martin Cogan, Food Science
Mallow Co. Cork, Ireland
- Dissertation: Components in Tomato Juice Stimulatory and Inhibitory for Lactobacilli. (Under the direction of Marvin Luther Speck).
- Charles Alfred Davis, Applied Mathematics
Raleigh, North Carolina
- Dissertation: Boundary Value Problems for Wedges and Cones Under Heat Conduction. (Under the direction of Walter Joel Harrington).
- †Romulo Adre Del Castillo, Forestry
Pangil, Laguna, Philippines
- Dissertation: Studies on the Stem Form of Water Tupelo (*Nyssa aquatica* Linn.). (Under the direction of William LeRoy Hafley and Robert James Monroe).
- George Marvin Eargle, Applied Mathematics
Greensboro, North Carolina
- Dissertation: A Nonlinear Integro-Differential Equation Associated with a Class of Wedge Problems. (Under the direction of Walter Joel Harrington).
- †David Ernest Edmond, Crop Science
Beverly, England
- Dissertation: The Effects of Replanting and Missing Plants on the Yield, Quality, Grade Distribution and the Economics of Production of Flue-Cured Tobacco. (Under the direction of Guy Langston Jones).
- †Clyde Edsel Evans, Soil Science
Auburn, Alabama
- Dissertation: Ion Exchange Relationships of Aluminum and Calcium in Soils as Influenced by Organic Matter. (Under the direction of Eugene John Kamprath).
- Carl Warren Fatzinger, Entomology
Catskill, New York
- Dissertation: Rearing Successive Generations of *Dioryctria abietella* (D. and S.) (Lepidoptera: Phycitidae) on Artificial Media with Aspects on Nutrition of the Insect. (Under the direction of Maurice Hugh Farrier).

† In Absentia

Edward Carlyle Franklin, Forestry
Lake City, Florida

- Dissertation: Artificial Self-pollination and Natural Inbreeding in *Pinus taeda* L.
(Under the direction of Bruce J. Zobel and Gene Namkoong).

William Bryan French, II, Electrical Engineering
Flatwoods, Tennessee

- Dissertation: A Study of Iron as a Recombination Center in Germanium by a
Transient P-N Junction Technique. (Under the direction of Robert
Walter Lade).

Stephen DeWitt Fretwell, Biomathematics
Winchester, Virginia

- Dissertation: On Territorial Behavior and Other Factors Influencing Habitat Dis-
tribution in Birds. (Under the direction of H. L. Lucas).

†Don Woodson Goss, Soil Science
Edcouch, Texas

- Dissertation: Mica Weathering as Related to Mica Species and Soil Parent Mater-
ial in the North Carolina Slate Belt. (Under the direction of
Maurice Gayle Cook).

†Charles Leroy Hutchins, Electrical Engineering
Winston-Salem, North Carolina

- Dissertation: Charge Transients in Aluminum-Silicon Nitride-Silicon Capacitors.
(Under the direction of Robert Walter Lade).

†Bruce Owen Johnston, Experimental Statistics
Winnipeg, Manitoba, Canada

- Dissertation: Spacing of Information in the Simple Exponential Model. (Under
the direction of Arnold Herbert Edward Grandage).

†Alan Lee Jones, Plant Pathology
Lyndonville, New York

- Dissertation: The Seasonal Development of Tobacco Brown Spot, Caused by
Alternaria tenuis, in Relation to the Ontogeny of the Host. (Under
the direction of Charles Joseph Nusbaum).

Emam Mohamed Khalifa, Soil Science
Elsadein, Sharkeyah, Egypt

- Dissertation: Properties of Clay Skins in a Cecil (Typic Hapludult) Soil. (Under
the direction of Stanley Walter Buol).

Dong Wha Kim, Mechanical Engineering
Seoul, Korea

- Dissertation: Effect of Filament Friction on Extensional Behavior of Continuous
Filament Yarns. (Under the direction of Carl Frank Zorowski).

Johng Ryun Kim, Electrical Engineering
Seoul, Korea

- Dissertation: A Scattering Approach for the Characteristics of a Dielectric An-
tenna of Arbitrary Shape. (Under the direction of Gerhard Karl
Megla).

†Charles Cooper King, Jr., Crop Science
Leighton, Alabama

- Dissertation: Potential of Exotic Maize for Silage Production. (Under the direc-
tion of Donald Loraine Thompson).

† In Absentia

- †Bohun Baker Kinloch, Jr., Genetics
Charleston, South Carolina
- Dissertation: Genetic Variation in Susceptibility to Fusiform Rust in Loblolly Pine. (Under the direction of Bruce J. Zobel, Arthur Kelman, and Ellis B. Cowling).
- Nicholas Henry Kuehn, III, Nuclear Engineering
Chicago, Illinois
- Dissertation: A Study of Some Aspects of the Neutron Thermalization Problem. (Under the direction of Raymond LeRoy Murray).
- Sidney Edward Law, Biological and Agricultural Engineering
Pelham, North Carolina
- Dissertation: Charge Loss Phenomena Active on Liquid Droplets. (Under the direction of Henry Dittimus Bowen).
- Peter Wendell McDonald, Mechanical Engineering
Thomasville, North Carolina
- Dissertation: Theory of the Cylindrical Langmuir Probe in a Flowing Collisionless Plasma. (Under the direction of Frederick O. Smetana).
- †Samir Ali Mohamed, Botany
Tockh, Kalubia, Egypt
- Dissertation: Effect of Root Aeration at Different Salinity Levels on Cell Division in *Vicia faba* L. Roots. (Under the direction of Ralph Edward Williamson and Glenn Ray Noggle).
- †Francis Joseph Morris, Electrical Engineering
Windsor, North Carolina
- Dissertation: A Study on the Effects of the Surface Potential on the Surface Recombination Velocity at a Silicon-Silicon Oxide Interface. (Under the direction of Robert Walter Lade).
- †Sydney Walter Nelson, Genetics
Causeway, Salisbury, South Rhodesia
- Dissertation: Observed and Expected Response of Yield and Stalk Strength to Full-Sib Family Selection in a Population of Maize. (Under the direction of Robert Harry Moll).
- †Willie Ocasio-Cabanas, Physics
Mayaguez, Puerto Rico
- Dissertation: Studies of Diffusion Parameters of Heterogeneous Systems and Systems with Voids by the Pulsed Neutron Technique. (Under the direction of Arthur Walter Waltner and Wesley Osborne Doggett).
- Claud Ervin Pugh, Engineering Mechanics
Asheboro, North Carolina
- Dissertation: Couple Stresses in Electrostriction and Magnetostriction. (Under the direction of Manohar Singh).
- Mahabir Pershad Sharma, Animal Science
Narnaul, India
- Dissertation: Immunochemical Studies of Cellulases from Several Strains of *Ruminococcus flavefaciens*. (Under the direction of James Murray Leatherwood).
- †Blair Joseph Smith, Economics
Gainesville, Florida
- Dissertation: The Dairy Cow Replacement Problem and the Determination of Optimal Replacement Policies. (Under the direction of Richard Adams King).

† In Absentia

Glenn Austin Snow, Plant Pathology
Long Beach, Mississippi

Dissertation: Environmental Factors Related to the Epidemiology of Fusiform Rust. (Under the direction of Ellis Brevier Cowling).

†Larry Franklin Stikeleather, Biological and Agricultural Engineering
Stony Point, North Carolina

Dissertation: The Development of an Active Seat Suspension System for Off-Road Vehicles. (Under the direction of Charles Wilson Suggs).

†David Allen Stock, Genetics
Elyria, Ohio

Dissertation: Photosynthesis, Respiration, and Transpiration by Susceptible and Resistant Mimosa Inoculated with *Fusarium oxysporum*. (Under the direction of Thomas O. Perry and Frank B. Armstrong).

Akio Suzuki, Genetics
Tokyo, Japan

Dissertation: Variances of Genetic, Maternal, and Reciprocal Effects in Flue-Cured Varieties of *Nicotiana tabacum* L. (Under the direction of Dale Frederick Matzinger).

†James Chien-Hua Tan, Genetics
Canton, China

Dissertation: Nonorientation and Precocious Disjunction of Meiotic Chromosomes in Two Diploid ($2n=24$) Solanum Species and Their F_1 Inter-specific Hybrid. (Under the direction of Frank Lloyd Haynes, Jr.).

Fred Toney, Jr., Applied Mathematics
Raleigh, North Carolina

Dissertation: Involutionary Matrix Representations of Reciprocal Automorphisms of Modules Over Residue Class Rings of Integers. (Under the direction of Jack Levine).

Grover Karl Warmbrod, Applied Mathematics
Raleigh, North Carolina

Dissertation: The Distributional Finite Fourier Transform. (Under the direction of Raimond Aldrich Struble).

Jerry Lee West, Zoology
Boone, North Carolina

Dissertation: The growth and Reproduction of Three Intergeneric Centrarchid Hybrids. (Under the direction of Francis Eugene Hester).

†Thomas Ernest Wooten, Wood Technology
Hamlet, North Carolina

Dissertation: The Effects of Indole-acetic Acid and Gibberellic Acid on Some Wood Properties of Sweetgum (*Liquidambar styraciflua* L.) and Loblolly Pine (*Pinus taeda* L.) Seedlings. (Under the direction of Aldos Cortez Barefoot, Jr.).

†Walter Riley Wright, Animal Science
Hendersonville, North Carolina

Dissertation: Metabolic Interrelationship between Vanadium and Chromium. (Under the direction of Charles Horace Hill).

† In Absentia

DEGREES CONFERRED

July 14, 1967

August 24, 1967

January 19, 1968

School of Agriculture and Life Sciences



BACHELOR OF SCIENCE IN BIOLOGICAL AND AGRICULTURAL ENGINEERING

Jointly Administered by School of Agriculture and Life Sciences and
the School of Engineering

Gurnie Robert Lee, Jr. (January, 1968) Fremont

BACHELOR OF SCIENCE

Agricultural Economics

Frederick Thayer Coltrain (January, 1968) Oak City
Larry Martin Land (January, 1968) Dallas
Samuel Thomas Madren (July, 1967) Winston-Salem

Agronomy

David Andrew Boyd, Jr. (July, 1967) Waynesville
Bernie Rowland Edwards (January, 1968) Franklinton
William Robert Haddock (January, 1968) Greenville
Marion Franklin Howell (January, 1968) Wilson
Alexander Columbus Yarborough, III (January, 1968) Smithfield

Animal Science *

Raymond Owen Elliott (August, 1967) Oxford
Ronald Mitchell Ivie (January, 1968) Shelby
Charles Isaac Miller, Jr. (August, 1967) Yadkinville

**Leonard Eugene Morton (July, 1967)	Norwood
Fred Thomas Pugh, Jr. (August, 1967)	High Point
Daniel William Rudy, Jr. (January, 1968)	Raleigh

Biological and Agricultural Engineering

Myron Eric Furbee (July, 1967)	Plymouth
Neill Angus Morrison, III (July, 1967)	Garner
Wade Eugene Stikeleather (January, 1968)	Stony Point
Alexander Columbus Yarborough, III (January, 1968)	Smithfield

Biological Sciences

#**Georgeanne Stengele Hoegerman (January, 1968)	Brooklyn, N. Y.
Edward Allen James (July, 1967)	Rocky Point
Charles Smallwood, III (January, 1968)	Raleigh
Janice Jean Varon (January, 1968)	Raleigh

Botany

James Frazier Dawson (January, 1968)	Kinston
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Food Science

Millard Eugene Russell (January, 1968)	Albemarle
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Horticultural Science

Peng Leong Ang (August, 1967)	Raleigh
-------------------------------	---------

Plant Protection

William Earl Bailey (July, 1967)	Clinton
James Sherwood Cheatham (August, 1967)	Oxford

Poultry Science

William Columbus Burleson (July, 1967)	Albemarle
Clyde Sherrill Honeycutt (July, 1967)	Albemarle
Rodney Lynn Hutchens (January, 1968)	High Point
Hollis Ray Roberson (July, 1967)	Candler

Rural Sociology

Emery Francis Frekko (August, 1967)	Sanford
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Soil Science

*Thomas Dewey Hussey (August, 1967)	Robbins
Floyd Lee Peed (July, 1967)	Aurora
Keat Leong Tan (January, 1968)	Penang, Malaysia

* Honors ** High Honors # Honors Program

Zoology

Thomas Marvin Austin (January, 1968)	Lenoir
Daniel Holton Benfield (July, 1967)	High Point
Jerry Dale Bergeron (January, 1968)	Huntsville, Ala.
David Winstead Bradshaw (January, 1968)	Franklin, Va.
Carl Franklin Carpenter (January, 1968)	Rome, N. Y.
Freddie Kay Carr (August, 1967)	Clinton
Michael Bruce Covington (January, 1968)	Raleigh
Walter Nesbit Fleming (August, 1967)	Coats
*Barbara Jane Gaines (January, 1968)	Winston-Salem
**Jerry Lee Hardison (January, 1968)	Plymouth
Grover Cleveland Hill, Jr. (January, 1968)	Beulaville
*Harry Lee Jones (January, 1968)	Charlotte
Philip Jackson Lazenby (August, 1967)	Charlotte
*Jesse Gabriel Lee (July, 1967)	Four Oaks
Richard Stanley Linko (July, 1967)	New Bern
Irvin St. John Lucas (January, 1968)	Raleigh
Terrianna McMurry Myren (January, 1968)	Winston-Salem
Nancy Elizabeth Rose (January, 1968)	Fayetteville
Mary Elizabeth Scott (August, 1967)	Raleigh
Robert Edwin Smale (July, 1967)	Falls Church, Va.
John Joseph Weber (July, 1967)	Middleport, N. Y.

School of Education



BACHELOR OF SCIENCE IN EDUCATION

Agricultural Education

Chavous Omar Bradley (July, 1967)	Rutherfordton
RaeFord Daughtry (January, 1968)	Newton Grove
John William Dunham (January, 1968)	White Oak
Alton Phil Grady (January, 1968)	Micro
Anthony Eugene McLamb (January, 1968)	Benson
Don Larry McLamb (January, 1968)	Dunn
Zennic James Quinn, Jr. (January, 1968)	Seven Springs
Curtis Ray Rains (January, 1968)	Princeton

* Honors

** High Honors

Industrial Arts Education

James Caldwell (January, 1968)	Suffern, N. Y.
Hoyt Randolph Davenport, Jr. (July, 1967)	Creswell
Vance Edward Fisher, Jr. (July, 1967)	Durham
Robert Dudley Mason (January, 1968)	Raleigh
John Edward Matthews (January, 1968)	Sanford
Dang Thi Tuyet (January, 1968)	Saigon, Viet Nam

Mathematics Education

James Randell Allred (January, 1968)	Sanford
Bruce Huntley Barick (July, 1967)	Raleigh
John Cary Bolt, III (January, 1968)	Raleigh
Paul Lester Bumgarner (January, 1968)	Roaring River
*Sarah Anne Newbern Griffin (January, 1968)	Powell's Point
Mildred Lynette Harwell (July, 1967)	Georgetown, S. C.
*Sister Mary Hugh Mauldin (January, 1968)	Belmont
Joseph Addison May (January, 1968)	Burkeville, Va.
Jane Morris Rulnick (January, 1968)	Fayetteville
Michael Ray Sterling (August, 1967)	Raleigh
Donnie Sylvester Weaver (January, 1968)	Rocky Mount
Malcolm Blair White (January, 1968)	So. Yarmouth, Mass.

Science Education

George Clifford Baxter, Jr. (January, 1968)	Amityville, N. Y.
Ernal Willard Foster, Jr. (January, 1968)	Hatteras
LeRoy Corbett Hand, III (January, 1968)	Gatesville

Vocational Industrial Education

Leonard Henderson Cannady (January, 1968)	Franklinton
Robert Wayne Herndon (August, 1967)	Apex
Ernest Thaddeus Jefferson (January, 1968)	Belhaven
Nancy Elizabeth King (August, 1967)	Raleigh

BACHELOR OF SCIENCE IN INDUSTRIAL ARTS

David Grady Fussell, Jr. (January, 1968)	Belhaven
James Parrott Gardner (January, 1968)	Kinston
James Michael Harvell (January, 1968)	Troy
Leonard Lloyd Hendricks (January, 1968)	Cary
Donald Franklin Mowery (July, 1967)	Salisbury
Gary Wayne Norwood (July, 1967)	Mount Holly
Robert Kingsley Pentz, Jr. (August, 1967)	Atlanta, Ga.
*Edwin Bayard Pleasants (January, 1968)	Raleigh
William David Poindexter, Jr. (January, 1968)	Roanoke Rapids
David James Stockley (January, 1968)	Virginia Beach, Va.
Terry Allen Yoder (January, 1968)	Lincolnton

* Honors

School of Engineering



BACHELOR OF SCIENCE IN AEROSPACE ENGINEERING

Charles William Arvey (August, 1967)	Laurel, Del.
Richard Samuel Brown (July, 1967)	Carthage
Clayton Harley Thompson (July, 1967)	North Wilkesboro

BACHELOR OF SCIENCE IN CERAMIC ENGINEERING

* Robert Andrew Lawhon (August, 1967)	Carthage
Richard Lacy Matthis, Jr. (July, 1967)	Kinston
Larry Evan Shemer (January, 1968)	Yadkinville

BACHELOR OF SCIENCE IN CHEMICAL ENGINEERING

Glenwood Thomas Duncan (August, 1967)	Roxboro
Harold Hardinge, IV (August, 1967)	Charlotte Court House, Va
Ralph Julian Hill, Jr. (July, 1967)	McLean, Va

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

Robert John Bracken (July, 1967)	Sanford
John William Copeland, III (August, 1967)	Rockingham
David Miller Crenshaw, Jr. (January, 1968)	Raleigh
Cameron Reed Daniels (July, 1967)	Colerain
Ronald Elton Davenport (July, 1967)	Trenton
Carl Keith Dickinson (January, 1968)	Spring Lake
Harris Baker Gupton (July, 1967)	Louisburg
Hilton Springer Johnson (January, 1968)	Aurora
Donald Smathers Miller, III (January, 1968)	Hickory
Preston Smith Miller (August, 1967)	Statesville
Charles Larry Roberts (August, 1967)	Rutherfordton
Evangelos Theodoropoulos (January, 1968)	Athens, Greece
William Jerry Twiggs (July, 1967)	Raleigh
James Guy Wilson (August, 1967)	Garner
Jimmy Dale Woodie (January, 1968)	Laurel Springs

BACHELOR OF SCIENCE IN CIVIL ENGINEERING, CONSTRUCTION OPTION

John Thompson Haas (July, 1967)	Hudson
Donald Elwood Holloman (July, 1967)	Harrellsville
George Alexander Riedel (January, 1968)	Philadelphia, Penna

* Honors

BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING

Phillip Rooks Arthur (January, 1968)	Jacksonville
Richard Harris Cherry (January, 1968)	Williamston
Alfred Gregson Chiswell, Jr. (July, 1967)	Southern Pines
* Charles Cunningham, Jr. (August, 1967)	Durham
Shi-Pei Chu (January, 1968)	Hsin-Tien, Taipei
Alvin Ray Connelly (January, 1968)	Guilford County
Wade Anderson Davis (July, 1967)	Winston-Salem
Avijit De (January, 1968)	Calcutta, India
Robert Sullins Drew (January, 1968)	Greensboro
Timothy Irvin Edwards (July, 1967)	Raleigh
John Patterson Funderburke (January, 1968)	Charlotte
William Ralph Gongaware (August, 1967)	Miami, Fla.
Gary Alan Hall (August, 1967)	Dahlgren, Va.
* Ronald Dean Harris (August, 1967)	Boiling Springs
James Alfred Heaney (January, 1968)	Jacksonville, Fla.
* John Hiram Johnson, Jr. (January, 1968)	East Bend
Edward Russell Johnston, Jr. (August, 1967)	Belhaven
Joseph Allen Killough (January, 1968)	Indian Trail
Gary Stafford McCachren (January, 1968)	Harrisburg
John Edward McNeill (January, 1968)	Chapel Hill
Cesar Augusto Maso (August, 1967)	Santurce, Puerto Rico
James William Meeks (January, 1968)	Memphis, Tenn.
Hubert Edward Nelson, Jr. (July, 1967)	Greensboro
Roy Patrick Nelson, Jr. (July, 1967)	Bryson City
Thomas Leighton Ogburn, Jr. (January, 1968)	Greensboro
Dewey Benton Overman, II (January, 1968)	Wilson
Robert Louis Owens (January, 1968)	Greensboro
Ronald McGehee Page (August, 1967)	Ruffin
John David Paul (July, 1967)	Belhaven
Julius Grey Pelt (July, 1967)	Goldsboro
Donald Rayford Poteat (August, 1967)	Salisbury
Kenneth Roger Rader (January, 1968)	Newton
Donald Steven Rogers (January, 1968)	Salisbury
Walter Edward Samuels (January, 1968)	Winston-Salem
Ronald Francis Smee (August, 1967)	New Cumberland, Penna.
Marson Wayne Sykes (January, 1968)	Weldon
Theodore Edward Taylor (January, 1968)	Forest Heights, Md.
Kermit Adrian Thompson, Jr. (January, 1968)	La Grange
Harold Wayne Tuttle (August, 1967)	High Point
William Jason Vaughan, III (July, 1967)	Roanoke Rapids
Thomas Vann Willard (January, 1968)	Raleigh
Crawford Edgar Williams (January, 1968)	Raleigh

BACHELOR OF SCIENCE IN ENGINEERING OPERATIONS

Claude Davis Allen (January, 1968)	Greensboro
Robert King Baeder (January, 1968)	Cedar Grove, N. J.
Robert Herman Ball (January, 1968)	Mount Airy
James Vernon Bellflower (August, 1967)	Robersonville
Michael Humphrey Bernard (January, 1968)	Greens Farms, Conn.

• Honors

Dale Linwood Brown, Jr. (July, 1967)	Raleigh
Howard Patrick Brown (August, 1967)	Washington
Carlton Ray Broome (January, 1968)	Mount Holly
Robert MacDonald Bryson (August, 1967)	Sylva
Philip Campbell Chapman (July, 1967)	Charlotte
James Allen Coleman (January, 1968)	Wilmington
John Vincent DeMaso (January, 1968)	Staunton, Va.
Samuel Jervay DuPre, III (August, 1967)	Spartanburg, S. C.
Gorden Francis Duckett (January, 1968)	Asheville
Henry Nelson Furman (January, 1968)	Charlotte
Thomas Richard Gerrity (January, 1968)	Goldsboro
Robert Joseph Girard, Jr. (January, 1968)	Charlotte
Ronald Steel Goodman (January, 1968)	Charlotte
Edwin Eugene Harris (August, 1967)	Shelby
Gabriel Jaime Henao (January, 1968)	Cali-Colombia, South America
John Robert Icard (January, 1968)	Rutherford College
Fred Dennis Johnson (January, 1968)	High Point
John Albert Johnston, Jr. (July, 1967)	Burlington
James Ralph Kirkman, Jr. (January, 1968)	Charlotte
*James McGee Lackey, Jr. (January, 1968)	Hickory
Thomas Pinckney Lauppe (January, 1968)	Charlotte
George Michael Ledermann (January, 1968)	Virginia Beach, Va.
Aldo Leon Livera, Jr. (January, 1968)	Madison, N. J.
Lawrence Reginald McDonald (January, 1968)	Aberdeen
James Ronald McKenhan (July, 1967)	Greensboro
Marvin Ray Martin (January, 1968)	Salisbury
Robert Stephen Morrow (January, 1968)	Goldsboro
John Christopher Queen (January, 1968)	Shelby
Albert Truett Ray (January, 1968)	Durham
Edward Reeves Short (July, 1967)	Mount Airy
Thomas Stanley Smith (January, 1968)	Hamlet
Jerry Wayne Stallings (July, 1967)	Gibsonville
William Heath Starnes (January, 1968)	Waxhaw
Clyde Allen Styron (January, 1968)	Hobucken
Victor Wayne Whitted (January, 1968)	Graham
Kent Boyd Williams (January, 1968)	Raleigh

BACHELOR OF SCIENCE IN FURNITURE MANUFACTURING AND MANAGEMENT

Marshall Neil Bordeaux (January, 1968)	Ingold
Edward Maxwell Christenbury (January, 1968)	Harrisburg
Roger Glenn Daniels (January, 1968)	Oak City
Stephen Ellis Hunt (July, 1967)	Rocky Mount
Richard Esten Meador (January, 1968)	Greensboro
Geoffrey Gordon Smith (January, 1968)	Great Notch, N. J.
Eddie Arnold Williams (August, 1967)	Morganton

BACHELOR OF SCIENCE IN GEOLOGICAL ENGINEERING

Victor Owen Cordle (January, 1968)	Cary
Clifford Darrell Crowder (August, 1967)	Gastonia

• Honors

Joseph Anthony Glenn (August, 1967)	Prospect, Va.
Ralph Sidney Prestwood, Jr. (January, 1968)	Lenoir
Tony Andrew Propst (January, 1968)	Cherryville

BACHELOR OF SCIENCE IN INDUSTRIAL ENGINEERING

Larry Thomas Edwards (January, 1968)	Fayetteville
Ronald Wesley Hargett (July, 1967)	Winston-Salem
*Rondall Stafford Presson (August, 1967)	Monroe
Philip Edward Taylor (January, 1968)	Akron, Ohio

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

*James Wilson Bowling (July, 1967)	Kinston
Jerry Mac Bradley (January, 1968)	Fuquay-Varina
*John Tilden Brittain (January, 1968)	Hickory
Richard Erven Cahoon (January, 1968)	Norfolk, Va.
*George William Crane, III (July, 1967)	Durham
Virgil Wayne Davis (January, 1968)	Norfolk, Va.
James Christopher Edmondson (July, 1967)	Bethel
Ronald Charles Edwards (August, 1967)	Sparta
Kenneth William Griffith (July, 1967)	Reidsville
Kuang Shen Huang (July, 1967)	Taiwan, China
Larry Lester Lang (January, 1968)	Gastonia
Mohammad Mazhar (January, 1968)	Karachi, Pakistan
Jerry Houck Mikeal (July, 1967)	Charlotte
Robert Michael Plasky (January, 1968)	Taylors, S. C.
George Basil Sarafidis (August, 1967)	Athens, Greece
Chirakitti Tangkathach (July, 1967)	Bangkok, Thailand

BACHELOR OF SCIENCE IN METALLURGICAL ENGINEERING

Arthur Erikson Capstaff, Jr. (July, 1967)	Newport News, Va.
Hal Quay Coggins (July, 1967)	Raleigh
Larry Randall Edwards (January, 1968)	Salisbury
Harvey Dean Freeman (January, 1968)	Kannapolis
Victor Leamon Lowery (January, 1968)	Marshville
Raymond Leith Martin, Jr. (August, 1967)	Durham
Robert Shaw Moore (August, 1967)	Wendell
Robert Isham Parnell, Jr. (August, 1967)	Lumberton
Thomas Dixon Pender (July, 1967)	Mebane
William Glenn Rains (January, 1968)	Kenly

BACHELOR OF SCIENCE IN NUCLEAR ENGINEERING

Donald Rex Gardner (July, 1967)	Smithfield
Jesse Bascom Marr, Jr. (January, 1968)	Thomasville
Ernest Cameron Seely, Jr. (August, 1967)	Charlotte

*** Honors**

School of Forest Resources



BACHELOR OF SCIENCE IN FORESTRY

Herbert Wayne Crase (August, 1967)	Whitesburg, Ky.
Frank Cleveland Dorman, III (August, 1967)	McMinnville, Tenn.
Larry Hilliard Harris (January, 1968)	Fayetteville
William Daniel McGill, II (August, 1967)	Lakeview
Lino Machado (January, 1968)	Puerto Cabezas, Nicaragua
Salah Rouchiche (July, 1967)	Algiers, Algeria
Robert Craig Schowalter (January, 1968)	Jackson, Miss.
•Wallace John Smith (August, 1967)	Brisbane, Australia
Raymond Douglas Warner (July, 1967)	North Falmouth, Mass.
Richard Dennis Weigel (January, 1968)	Rochester, N. Y.
Larry Lester Williams (January, 1968)	Hendersonville

BACHELOR OF SCIENCE IN PULP AND PAPER TECHNOLOGY

Khaja Nammuddin (July, 1967)	Hyderabad, India
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BACHELOR OF SCIENCE IN RECREATION AND PARK ADMINISTRATION

Richard Andrew Aldridge (January, 1968)	Concord
Donald Graham Broadwell (August, 1967)	Lillington
Ralph Lee Cannon, Jr. (August, 1967)	Winston-Salem
William Ray Carr, Jr. (January, 1968)	Goldsboro
Ronnie Hoyt Denton (January, 1968)	Zebulon
Jerry Lee Devine (January, 1968)	Shelby
Donald Devoe Donaldson (January, 1968)	Saxton, Penna.
Johnny Edward Ellen (August, 1967)	Raleigh
James Mason Donnan, III (January, 1968)	Burlington
Mervin Wilmer Gutshall, Jr. (January, 1968)	Elkins, W. Va.
Robert Paul Hudson (January, 1968)	Reidsville
✓•Lynne Davis Jones (January, 1968)	Raleigh
Donald Clayton Loomis (January, 1968)	Balboa, Calif.
Harry Richard Martell (January, 1968)	Penns Grove, N. J.
Harry Graham Petrey (January, 1968)	Gastonia
•James Winans Pfefferkorn (August, 1967)	Winston-Salem
Joe Richard Reed (January, 1968)	Elford
Kaaren Ann Schmidt (January, 1968)	Gastonia
•Lawrence Christian Schmidt (January, 1968)	New Providence, N. J.
Lloyd Christian Spangler (January, 1968)	Richmond, Va.
Stephen Harold Stewart (January, 1968)	Linville

• Honors

Victory Ann Strickland (January, 1968)	Alexandria, Va.
Robert Stuart Taylor (January, 1968)	Raleigh
Ronald Lee Wirth (January, 1968)	North East, Md.

BACHELOR OF SCIENCE IN WOOD TECHNOLOGY

Philip Arthur Araman (January, 1968)	Newburgh, N. Y.
Clyde Oscar Belangia, Jr. (January, 1968)	New Bern
Thomas Sanford Helms, Jr. (January, 1968)	Mahwah, N. J.
Sterling Beverley Hilliard, Jr. (January, 1968)	Weldon

School of Liberal Arts



BACHELOR OF ARTS

George Washington Allen, Jr. (August, 1967)	New Bern
John Carl Allen, Jr. (July, 1967)	Benson
Robert Parks Alexander (January, 1968)	Durham
Claude Russell Alley (August, 1967)	Marion
Sherrill Lee Atkins (August, 1967)	Saluda
Paul Joseph Baragona (August, 1967)	Winston-Salem
•Barney Martin Barco (January, 1968)	Fayetteville
Richard Bailey Bell (August, 1967)	Charlotte
Robert Askew Boone (July, 1967)	Gates
Raymond Charles Buday, Jr. (July, 1967)	Elizabeth City
Ronald Curtis Cain (July, 1967)	Elizabethtown
Robert Millard Carmany (January, 1968)	Euclid, Ohio
Gene Maynard Carver (January, 1968)	Roxboro
Willis Robert Caudle, II (July, 1967)	Halifax
•Mona Lee Cozart Chappell (August, 1967)	Knightdale
Patricia Thorpe Coggins (August, 1967)	Raleigh
John Allison Doerr (January, 1968)	Raleigh
Leete Raymond Doty (January, 1968)	Fairfield, Conn.
Frank Douglas Draffin, Jr. (January, 1968)	Raleigh
Randolph William Ellis (January, 1968)	Ft. Leavenworth, Kan.
Lottie Parrish Flowers (January, 1968)	Raleigh
John Edwin Foil, Jr. (July, 1967)	Raleigh
Robert Sterling Gingerh (July, 1967)	Greensboro
Eldon Lewis Hoffman (July, 1967)	Raleigh
Thomas Leroy Hood, III (January, 1968)	Dover

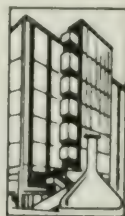
• Honors •• High Honors

Anthony Ogburn Honeycutt (January, 1968)	Raleigh
•• Patricia Anne Johnston (January, 1968)	Hendersonville
• Judson Lanier (January, 1968)	Sitka, Alaska
Thomas Bernard Leary, Jr. (January, 1968)	Morehead City
David Thomas McCutcheon (August, 1967)	Newburgh, N. Y.
•• Ann Kaufman Mandelbaum (August, 1967)	Raleigh
Philip Crawford Martin (January, 1968)	Raleigh
Judson James Milam, III (January, 1968)	Columbia, S. C.
Linda Marie Mitchell (July, 1967)	Portsmouth, Va.
Judith Fitzjohn Murdoch (July, 1967)	Charlotte
Lewis Graham Murray, II (July, 1967)	Raleigh
Michael Vernon Neese (August, 1967)	Greensboro
Edward Louis Pauley (August, 1967)	Charlotte
Edwin Lee Plowman (August, 1967)	Winston-Salem
David Allen Poole (July, 1967)	Raleigh
Charles Wesley Proctor (August, 1967)	Greensboro
William Raymond Ruehrwein, Jr. (January, 1968)	Guam
• Patricia Louise Salas (January, 1968)	Hopewell, Va.
• Virginia Wade Shearin (August, 1967)	Clayton
James Daniel Shearon (January, 1968)	Raleigh
Patrick Craig Simpson (January, 1968)	Raleigh
• Joyce Jones Smith (January, 1968)	Raleigh
Robert Sherrill Stephenson (January, 1968)	Clayton
James Edward Strawbridge (August, 1967)	Durham
Curtis Carlyle Tillotson, Jr. (July, 1967)	Oxford
•• Mary Van Lear Van Kirk (August, 1967)	Raleigh
Helvn Lynn Watson (January, 1968)	Raleigh
William Leon Webb, Jr. (January, 1968)	High Point
Russell Vernon Whitley (January, 1968)	Durham
•• Jane Woodlief Wilder (August, 1967)	Franklinton

BACHELOR OF SCIENCE

James Ronald Christie (January, 1968)	Raleigh
William Michael McNeill (January, 1968)	Raleigh
Robert Hewitt Merritt (August, 1967)	Burlington
Edmund Elmer Ruhland, Jr. (August, 1967)	Wilmington

School of Physical Sciences and Applied Mathematics



BACHELOR OF SCIENCE IN APPLIED MATHEMATICS

John William Bass (July, 1967)	Durham
Robert Mac Brunk (July, 1967)	Charlotte
• Honors	•• High Honors

Myron Luther Cauble, Jr. (July, 1967)	Kannapolis
Edgar Rene Chavez (July, 1967)	Raleigh
Warren Peter George Freas, III (January, 1968)	Raleigh
Bonnie Loyce Garrett, Jr. (January, 1968)	Atlanta, Ga.
•William Francis King (January, 1968)	Wilmington
Thomas Webb Langford, Jr. (July, 1967)	Thomasville
Kenton Robert Larson (August, 1967)	Asheville
Anthony John Mark (January, 1968)	Charleston, S. C.
Fred Whitaker Newton, Jr. (January, 1968)	Raleigh
••Iris Ann Friel Patrick (August, 1967)	Moyock
Edmund John Piaski, Jr. (August, 1967)	Kinston
Anthony Adam Schlegel (August, 1967)	Cary
••Lynn Beecher Spees (August, 1967)	Greenville, Tenn.
Maurice Ferrell Stanley (July, 1967)	Clyde
Walter Douglas Starr, Jr. (January, 1968)	Creswell
Ivey Miller Warren, Jr. (January, 1968)	Plymouth
••Rebecca Ann Wilson (January, 1968)	Raleigh

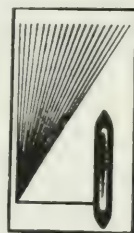
BACHELOR OF SCIENCE IN CHEMISTRY

Charles Ronald Williams (August, 1967)	Kannapolis
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BACHELOR OF SCIENCE IN PHYSICS

David Anthony Bass (August, 1967)	Fayetteville
William Frank Holden (August, 1967)	Charleston, S. C.

School of Textiles



BACHELOR OF SCIENCE IN TEXTILE CHEMISTRY

Herman Edgerton Allen (August, 1967)	Rocky Mount
Charles Harrison Bohrer (January, 1968)	Statesville
Horace Higgins, Jr. (January, 1968)	Burnsville
Lakshminarasimhan Krishnaswamy (January, 1968)	Bombay, India
Howard Charles Malpass, Jr. (August, 1967)	Jamestown
Youssef Loutfy Mansour (January, 1968)	Alexandria, Egypt
Charles Browning Moore (January, 1968)	Littleton
Robert Francis Palmer, III (January, 1968)	Spencer
William David Reeves (January, 1968)	Leicester

- Honors •• High Honors

Joseph Raymond Salem, Jr. (January, 1968)	Raleigh
William Edwin Sexton (January, 1968)	Cooleemee

BACHELOR OF SCIENCE IN TEXTILE TECHNOLOGY

Joseph Louis Ariagno (July, 1967)	Welland, Ontario, Canada
Guy Philip Barnes (January, 1968)	Welcome
John Carlton Baucom, Jr. (July, 1967)	Cary
Mitchel Wayne Baucom (August, 1967)	Kannapolis
Charlie Sylvester Benton (July, 1967)	Concord
Robert Maurice Cannon (January, 1968)	Long Island, N. Y.
Kenneth Wayne Cochran (January, 1968)	Forest City
John Robert Dunivant (August, 1967)	Leaksville
Robert Perry Elmore (January, 1968)	Belmont
Jeff Ingram Fitch (July, 1967)	Burlington
Charles Douglas Frick (August, 1967)	Salisbury
George Roderick Gemayel (January, 1968)	Spencer
Horace Higgins, Jr. (January, 1968)	Burnsville
Raymond Jackson Hoots, Jr. (July, 1967)	Winston-Salem
Jerry Dallas James (January, 1968)	Winston-Salem
Charles Alonzo Jones (August, 1967)	Apex
David Khalifa (August, 1967)	Jerusalem, Israel
•• Riaz Ahmad Khan (January, 1968)	Sahiwal, Pakistan
Jean-Guy LeDuc (July, 1967)	Verdun, Quebec, Canada
John Glendon Morgan (July, 1967)	Mount Holly
Wilbur Larry Ownley (August, 1967)	Elizabeth City
Allen Brown Parker (January, 1968)	Mount Ulla
Ralph Alexander Petrone (January, 1968)	Rensselaer, N. Y.
Leon Alton Pittman, Jr. (July, 1967)	Kinston
Fred Thomas Potts (January, 1968)	Thomasville
Raja Abdul Rashid (July, 1967)	Rawalpindi, W. Pakistan
Terry Wadsworth Ridenhour (January, 1968)	Kannapolis
Chaim Shweitz (August, 1967)	Bnei-Braq, Israel
William Ashley Smith (January, 1968)	Kinston
Danny Stuart Swaim (January, 1968)	Elkin
Jesse Gray Thomas (January, 1968)	Bethel
Gaston Verreault (August, 1967)	Granby, Quebec, Canada
Stanford Chester West, Jr. (August, 1967)	Raleigh
Michael Joseph White (January, 1968)	St. Albans, W. Va.
James Randolph Woodlief (August, 1967)	Durham
John Ross Yoder, Jr. (January, 1968)	Lincolnton

Professional Degrees



Civil Engineer, Structural Option

Suraphol Assakul (July, 1967)	Bangkok, Thailand
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•• High Honors

Civil Engineer, Transportation Option

Robert Lawson Anderson (January, 1968)	North Wilkesboro
James Richard Atkins (January, 1968)	Kernersville

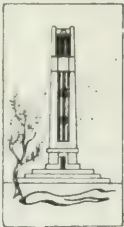
Industrial Engineer

Kenneth Franklin Roberts (August, 1967)	Knoxville, Tenn.
Madhukar Badaravan Sangoram (January, 1968)	Bombay, India

Mechanical Engineer

Vikram N. Shah (August, 1967)	Bombay, India
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Masters Degrees



MASTER OF AGRICULTURE

William Gordon Bacon (January, 1968)	Somerset, Ky.
Francisco Ramon Ferrer (January, 1968)	Lima, Peru
Roy Franklin Heltzel (July, 1967)	Culpeper, Va.
Harold Leon Lile (August, 1967)	Jackson, Tenn.

MASTER OF APPLIED MATHEMATICS

Joby Milo Anthony (January, 1968)	Orlando, Fla.
Sarkis K. Garibian (August, 1967)	Cary
Christopher Robert Kopf (January, 1968)	Sacramento, Calif
Frederick Willard Nagle (August, 1967)	Norfolk, Va.
Stephen Kent Park (August, 1967)	Martinsburg, Penna.
Edward Keith Tester (January, 1968)	Blowing Rock

MASTER OF ECONOMICS

Muhammad Akhtar (August, 1967)	Gujranwala, Pakistan
Everett Pleasant Chesley (August, 1967)	Raleigh
James Clarence Crew (January, 1968)	Raleigh
Herman Frederick Gallasch, Jr. (August, 1967)	Richmond, Va.
William Harrington Keel, II (January, 1968)	Raleigh
Jerry Lawrence Mangum (January, 1968)	Raleigh
Anibal Gomez Monares (August, 1967)	Osorno, Chile
Wilhelmus Liberte Nieuwoudt (July, 1967)	Pretoria, South Africa
Robert Lee Self, III (January, 1968)	Burlington

Alton Skinner, III (January, 1968)	Durham
Michael Wavland Smith (January, 1968)	Raleigh
Thomas Eugene Taylor (January, 1968)	Deep Run

MASTER OF EDUCATION

Adult Education

Eccles Lee Leak (August, 1967)	Roxboro
Albert Reynolds Lounsbury (January, 1968)	Saratoga Springs, N. Y.
Anne Johnson Postell (January, 1968)	Waycross, Ga.
George Broughton Spence, Jr. (January, 1968)	Lillington

Agricultural Education

Curtis Tapp Shivar (January, 1968)	Seven Springs
Henry Alvin Pasour (January, 1968)	Dallas
George Donald O'Quinn (January, 1968)	Mamers

Guidance and Personnel Services

Eula Elizabeth Peterson Alexander (January, 1968)	Raleigh
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Industrial Arts Education

Joseph Hugh Nanney (August, 1967)	Hendersonville
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Mathematics Education

Wayne Wesley Thomas (August, 1967)	Apex
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Occupational Information and Guidance

Gary Kent Hale (August, 1967)	Jeffersonville, Ind.
Sam Pierce Harrell, Jr. (July, 1967)	Wadesboro

Vocational Industrial Education

Robert Jenkins Graham (July, 1967)	Haw River
Vincent Cowgill Outland (August, 1967)	Raleigh
Julian Cooper Wingfield, Jr. (July, 1967)	Durham

MASTER OF ELECTRICAL ENGINEERING

Joe Houston Duncan (January, 1968)	Franklin, Tenn.
Joseph Patrick Halloran, Jr. (January, 1968)	St. Marys, Penna.
Dale Fidel Hicks (August, 1967)	San Antonio, Texas
Chung-Wen Liu (January, 1968)	Taichung, Taiwan
James William McGowan (July, 1967)	Birmingham, Ala.
Henry Ervin Poe (January, 1968)	Thomasville
John Luther Prince, III (January, 1968)	Dallas, Texas
Jay Keitt Sawyer (January, 1968)	Vanceboro
David Michael Smith (January, 1968)	Concord

Robert Frederick Steen (August, 1967)	Meadville, Penna.
Hugh Carlyle Willard (January, 1968)	Washington

MASTER OF EXPERIMENTAL STATISTICS

Carlyle Andrew Clayton (January, 1968)	Raleigh
Albert Dionne (January, 1968)	Quebec, Canada
Carl Leroy Dyer (January, 1968)	Princeton, Ill.
Burt S. Holland (January, 1968)	Flushing, N. Y.
Gilberto Paez-B (January, 1968)	Loreto, Paraguay
George Ankutse Paku (January, 1968)	Kpandu, Ghana
Jean-Marc Picard (January, 1968)	Montreal, Canada
Lawrence Henry Pope (January, 1968)	Woodbridge, Va.
Gary Merrill Shapiro (January, 1968)	Huntington Woods, Mich.
Michael Walter Sherrill (January, 1968)	Troutman
Sidney Stanley Young (January, 1968)	Raleigh
Sami Abdulla Zarka (August, 1967)	Amman, Jordan

MASTER OF MECHANICAL ENGINEERING

Dilip Shantilal Palkhiwala (January, 1968)	Ahmedarad, India
Clarence Eugene Roberson, Jr. (January, 1968)	Ahoskie
Riaz Ahmed Siddiqui (January, 1968)	Hyderabad, India

MASTER OF TEXTILE TECHNOLOGY

James Blythe Brown (August, 1967)	Goldsboro
Stephen Woodrow Foss (July, 1967)	Haverhill, Mass.
Mojtaba Mostashari (January, 1968)	Iran
Farouk Mohamed Youssef (January, 1968)	Cairo, Egypt

MASTER OF ARTS

Economics

William Vernon Pace (August, 1967)	Florence, Ala.
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MASTER OF SCIENCE

Adult Education

Donald Carroll Parker (August, 1967)	Brevard
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Agricultural Economics

Jose Enrique Fernandez (August, 1967)	Lima, Peru
David Richard Hayes (January, 1968)	Argyll, Scotland
Madjid Koopahi (January, 1968)	Tabriz, Azarbaydjan
Richard Douglas Robbins (January, 1968)	Ahoskie

Agricultural Education

Lewis Conrad Forrest, Jr. (July, 1967)	Newport
--	---------

Animal Ecology

- Jerry Lawrence Holloman (July, 1967) Jackson
Paul Wesley Sykes, Jr. (July, 1967) Norfolk, Va.

Animal Science

- John Ernest Albrecht, III (January, 1968) Cheltenham, Penna.
Julian Alberto Buñrigo A. (January, 1968) Calarca, Colombia, S.A.
Douglas Wilson Eason (January, 1968) Jackson
Frank Ripley Fenton (January, 1968) Williamstown, W. Va.
George Lynn Hargrove (January, 1968) Pulaski, Iowa
Ling-Jung Koong (January, 1968) Taipei, Taiwan
Ernesto Huertas Vega (January, 1968) Bogota, Colombia, S.A.
William Ellis Vinson (January, 1968) Charlotte

Biological and Agricultural Engineering

- Thomas Lynn Honeycutt (January, 1968) High Point
Eugene Wallace Rochester, Jr. (January, 1968) Greenville, S. C.
Chung-Jin Shaw (January, 1968) Taipei, Taiwan
Chao Shan Su (August, 1967) Raleigh

Botany

- Dora Cynthia Glazier (January, 1968) Wytheville, Va.
Raswati Soetiarso (January, 1968) Djakarta, Indonesia
William Edward Spooner (August, 1968) Wilmington

Ceramic Engineering

- David Ray Johnson (January, 1968) Fayetteville
William Henry Mason, Jr. (August, 1967) Westborough, Mass.
David Emmett Witter (August, 1967) Raleigh

Chemistry

- George Shuford Abernethy, Jr. (August, 1967) Hickory

Civil Engineering

- James Ashley Aberson, Jr. (January, 1968) Charlotte
John Rodman Andrew (January, 1968) Washington
Bryant Terry Brothers (August, 1967) Elizabeth City
William John Cameron (January, 1968) Raleigh
Ching Feng Chen (January, 1968) Kaohsiung, Taiwan
Albert Sidney Daughtridge, Jr. (January, 1968) Scotland Neck
James Fuel Fulton, III (August, 1967) Greensboro
Hota Venkata Surya Gangarao (January, 1968) Raleigh
Robert Sarratt Gidney, Jr. (August, 1967) Shelby
Rudy Lee Griffin (August, 1967) Durham
Karl Robert Leimbach (August, 1967) Hamburg, Germany
Roger Dale Lewis (August, 1967) Decatur, Ga.
Owen McNulty (January, 1968) Fayetteville

Hossein Mahban (January, 1968) Tehran, Iran
 Walter Warren Miller, Jr. (August, 1967) Raleigh
 James Lee Zimmerman, Jr. (August, 1967) Lexington

Crop Science

Oscar Elwood Hatley (August, 1967) Albemarle
 George Louis Hosfield (January, 1968) Manasquan, N. J.

Electrical Engineering

Charles Leslie Britt, Jr. (July, 1967) Durham
 Roy Herman Propst (January, 1968) Spencer

Engineering Mechanics

Evan Charles Brown, Jr. (July, 1967) New Orleans, La.

Entomology

Paul Rong Sheng Chen (January, 1968) Taiwan, China
 Robert Richard Willis (January, 1968) New Hyde Park, N. Y.
 Raymond Shih-Hsien Yang (August, 1967) Taiwan, China

Food Science

Mieko Karube Suzuki (January, 1968) Tokyo, Japan
 James Warren Swain (January, 1968) Columbia

Forestry

William Henry Gauger (January, 1968) Chapel Hill
 Samuel Buchanan Land, Jr. (January, 1968) South Hill, Va.
 Marcelino Quijada Rosas (January, 1968) Anzoategui, Venezuela

Genetics

Carole Johnson Elliott (August, 1967) Millville, N. J.
 Sydney Walter Nelson (January, 1968) Salisbury, Rhodesia

Industrial Arts Education

Johnny Lee Crow (January, 1968) Lincolnnton

Industrial Engineering

Kamalnayan Bhalashanker Pandya (July, 1967) Ahmedabad, Gujarat
 Stanley Trustman (July, 1967) Mountaindale, N. Y.

Mathematics Education

Allison Dwight Monroe (January, 1968) Robbins
 Roby Stephen Painter (January, 1968) Banner Elk

Mechanical Engineering

James Ronald Bailey (January, 1968)	Marion
Harry Lee Beach, Jr. (January, 1968)	Raleigh
Michael Alston Boles (August, 1967)	Jonesville
Vijayprasad Dolatrai Desai (January, 1968)	Sarthana, India
Kamlesh Anubhai Jhaveri (July, 1967)	Gujarat, India
Suresh Damodaradas Kadakia (January, 1968)	Gujarat, India
Lalji Haribhai Khant (January, 1968)	Gujarat, India
Mike Yuan Lee (January, 1968)	Chung King, China
David Sanders Miller (July, 1967)	Concord
Rudolph Euell Oliver, II (January, 1968)	Pine Level
Hanish Anandbhai Patel (January, 1968)	Ahmedabad, India
Robert Kincaid Seals, Jr. (January, 1968)	Charlotte
Kamlesh Champaklal Shah (August, 1967)	Ahmedabad, India
Ranjit Kantilal Shah (July, 1967)	Bombay, India
Song-Fang Wu (July, 1967)	Taiwan, China

Metallurgical Engineering

John Montgomery Brett (January, 1968)	Ahoskie
Boyce Edward Miller, Jr. (January, 1968)	Charlotte

Microbiology

Bernard Britt Keele, Jr. (July, 1967)	Huntsville, Ala.
Mildred Abernethy Kerbaugh (January, 1968)	Raleigh
Thomas Tyler Lillich (January, 1968)	Cincinnati, Ohio
Helen Deloris Lilly (August, 1967)	Raleigh
Lorain Medbury Schultes (January, 1968)	Mount Upton, N. Y.

Nuclear Engineering

Bertram Arnold Bunting (July, 1967)	Norfolk, Va.
Thomas Richard Horton (July, 1967)	Charlotte
Madhavan Gopalakrishnan Nayar (January, 1968)	Trivandrum, Kerala, India
Robert Earl Surratt (January, 1968)	Greensboro

Occupational Information and Guidance

David Charles Nash (August, 1967)	Chapel Hill
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Physics

Maria Del Carmen Cassano (August, 1967)	Lima, Peru
Richard Miller Morgan (August, 1967)	Asheville
Jan Willem Luning Prak (January, 1968)	The Hague, Netherlands

Physiology

Stuart Craig Smith (August, 1967)	New York, N. Y.
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Plant Physiology

Otto John Schwarz (August, 1967)	Fort Myers, Fla.
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Poultry Science

Elsa Cartwright Anders (August, 1967)	Hendersonville
Tarek Mohamed El-Ackad (August, 1967)	Alexandria, Egypt
Kinh Nguyen Hall (August, 1967)	Vinh Binh, Viet Nam

Psychology

Roy Franklin Musten, Jr. (August, 1967)	Winston-Salem
Paul Schnur (January, 1968)	New York, N. Y.
Ruth Blakeslee Shaw (January, 1968)	Raleigh

Science Education

Catherine Gwendolyn Meredith Ellor (January, 1968)	High Point
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Soil Science

Charles Lee Mulchi (July, 1967)	Norlina
John Howard Reeves (August, 1967)	Covington, Tenn.

Textile Chemistry

Walter Werner Lebensaft (January, 1968)	Baden, Austria
Joel Lawson Williams (January, 1968)	Pink Hill

Textile Technology

Eugene Yeu Zen Cheng (August, 1967)	Hong Kong
George Robert Johnson (August, 1967)	Wilmington

Wildlife Biology

Edward John Carpenter (August, 1967)	Fredonia, N. Y.
Robert Linn Wilbur (July, 1967)	Haverford, Penna.
Charles Robert Stroud, Jr. (January, 1968)	Goldsboro

Wood Technology

Thomas Parker Feters (January, 1968)	Ann Arbor, Mich.
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Zoology

Claude Cecil Crawford, III (January, 1968)	Raleigh
Larry Dee Hendricks (January, 1968)	Wakita, Okla.
John Francis Vance, Jr. (January, 1968)	Kernersville

Doctor of Philosophy Degrees

- Hosni Ahmad Abou-El-Fittouh, Experimental Statistics and Crop Science (August, 1967)
Cairo, U. A. R.
- Dissertation: Genotype by Environment Interactions in Cotton—Their Nature, Related Environmental Factors, and Implications in Zoning. (Under the direction of John Oren Rawlings and Philip Arthur Miller).
- David Mitchell Allen, Experimental Statistics (January, 1968)
Sebree, Kentucky
- Dissertation: Multivariate Analysis of Nonlinear Models. (Under the direction of James Ennis Grizzle).
- Doyle Allen Ashley, Soil Science (January, 1968)
Collinsville, Alabama
- Dissertation: Nitrate Uptake and Assimilation by Low-N Wheat Seedlings from $\text{Ca}^{14}\text{NO}_3$ Solution. (Under the direction of William A. Jackson).
- David Hugh Ashton, Food Science (January, 1968)
Rivers Manitoba, Canada
- Dissertation: Inhibition of *Bacillus stearothermophilus* by Milk Components. (Under the direction of Francis Fredrick Busta).
- Walter Martin Britton, Animal Science (January, 1968)
Lasker, North Carolina
- Dissertation: Relationships between Zinc Nutrition and Alkaline Phosphatase Activity in the Chick. (Under the direction of Charles Horace Hill).
- Paul Chun-Yung Chen, Mechanical Engineering (January, 1968)
Fukien, China
- Dissertation: Theoretical Investigation of Some Mass Transfer Problems With Radioactive Decay and Wall Reaction. (Under the direction of Mehmet Necati Ozisik).
- Robert Lawrence Christensen, Economics (August, 1967)
Lakeview, Michigan
- Dissertation: A Study of the Relation between Income and Egg Consumption Using Consumer Panel Data. (Under the direction of Thomas Dudley Wallace).
- James Edwin Clark, Civil Engineering (July, 1967)
Columbia, South Carolina
- Dissertation: The Use of Drivometer Events to Measure Traffic Volumes. (Under the direction of Paul Day Cribbins).
- Robert Irvin Coltrane, Economics (January, 1968)
Sophia, North Carolina
- Dissertation: A Statistical Test of the Economic Base Approach to Area Economic Analysis. (Under the direction of Paul Reynolds Johnson and William Douglas Toussaint).
- Juan Antonio Comerma, Soil Science (January, 1968)
Barquisimeto, Lara, Venezuela
- Dissertation: Characteristics and Genesis of Two Soil Associations in North Central Venezuela. (Under the direction of Ralph Joseph McCracken).
- Thomas Clay Dellinger, Mechanical Engineering (January, 1968)
Albemarle, North Carolina
- Dissertation: Theoretical Investigation of Liquid Water Injection into the Shock Layer of a Reentry Vehicle. (Under the direction of Hassan Ahmad Hassan).

- Richard Pence Dowdy, Animal Science and Biochemistry (August, 1967)
Greenville, West Virginia
- Dissertation: Investigation of the Chemical Basis of the Biological Effects of the Copper-Molybdenum Interaction. (Under the direction of Gennard Matrone).
- Taha Ahmed El-Sharkawy, Plant Pathology (August, 1967)
Tanta, U. A. R.
- Dissertation: Bacteriophage Reactions and Pathogenic Spectra of *Xanthomonas* Species to Cotton. (Under the direction of William Earl Cooper).
- Anna Clyde Fraker, Ceramic Engineering (July, 1967)
Raleigh, North Carolina
- Dissertation: The Eta Carbides of Molybdenum-iron, Molybdenum-cobalt, and Molybdenum-nickel. (Under the direction of Hans Heinrich Stadelmaier).
- John O'Neil Gerald, Economics (January, 1968)
Loris, South Carolina
- Dissertation: Prices, Trade Flows and Formula Pricing of Shell Eggs in the United States. (Under the direction of James Claude Williamson, Jr.).
- Aubrey Brewer Gosnell, Chemistry (August, 1967)
Durham, North Carolina
- Dissertation: The Synthesis and Characterization of Well-Defined Branched Polymeric Molecules with Anionic Polymerization. (Under the direction of Vivian Thomas Stannett).
- John Graham, Entomology (January, 1968)
New York City, New York
- Dissertation: Principles of Crowding Effect in *Aphis gossypii* Glover (Aphididae, Homoptera). (Under the direction of Clyde Fuhrman Smith).
- Creighton Lee Gupion, Crop Science (August, 1967)
Castalia, North Carolina
- Dissertation: The Heritability of Maturation Indices Associated with Specific Growth Periods in Virginia Type Peanuts. (Under the direction of Donald Allen Emery).
- George David Gwyer, Economics (August, 1967)
Surrey, England
- Dissertation: Determinants of Long-Term Capital Flows to Peru, 1950-1965. (Under the direction of Paul Reynolds Johnson).
- Bernard Ray Haskins, Animal Science (January, 1968)
Lakeland, Florida
- Dissertation: The Influence of Low Levels of Roughages and Roughage Substitutes on Performance Rumen Environment, Rumen Parakeratosis and Liver Abscesses of Steers Fed High Energy Rations. (Under the direction of Milton Bee Wise).
- Fredric Hathorn, Animal Science (July, 1967)
Lafayette, Louisiana
- Dissertation: Effects of the Addition of Materials of Different Nutritive Potential to the Rumen of the Steer. (Under the direction of James Edward Legates and Allen Huff Rakes).
- Bruce Sword Heming, Entomology (January, 1968)
Guelph, Ontario, Canada
- Dissertation: Postembryonic Development of the Male and Female Reproductive Systems of *Frankliniella fusca* (Hinds) (Thripidae) and *Haplothrips verbasci* (Osborn) (Phlaeothripidae) (Thysanoptera). (Under the direction of William Vernon Campbell).

- Alva William Johnson, Plant Pathology (July, 1967)
Tifton, Georgia
- Dissertation: Ecological Associations Between Certain Species of Plant Parasitic Nematodes in Mixed Populations. (Under the direction of Charles Joseph Nusbbaum).
- Thomas Kent Kirk, Plant Pathology, Biochemistry (January, 1968)
Natchitoches, Louisiana
- Dissertation: Oxidation and Oxidative Cleavage by White-Rot Fungi of Model Compounds Closely Related to Lignin. (Under the direction of Ellis Brevier Cowling, Samuel B. Tove, and Arthur Kelman).
- Kenneth Lowell Koonce, Animal Science (January, 1968)
Iowa, Louisiana
- Dissertation: Associations of Birth Weight and Gestation Length with Preweaning Growth in Beef Cattle (Under the direction of James Edward Legates).
- Sham Sunder Kumar, Entomology (August, 1967)
N. Delhi, India
- Dissertation: Choline Metabolism in Insects. (Under the direction of Ernest Hodgson).
- Leung Wang Lau, Nuclear Engineering (January, 1968)
Hong Kong, China
- Dissertation: An Acoustical and Optical Study of Cavitation Noise. (Under the direction of Raymond Frederick Saxe).
- Sung Won Lee, Experimental Statistics (July, 1967)
Seoul, Korea
- Dissertation: A Probability Model for Random Fiber Breakage. (Under the direction of John William Bishir).
- Tung Liang, Biological and Agricultural Engineering (January, 1968)
Taipei, Taiwan
- Dissertation: A dynamic Programming Markov Chain Approach to Farm Machinery Preventive Maintenance Problems. (Under the direction of David Alan Link).
- Frank Duff Mason, Experimental Statistics (August, 1967)
Kennewick, Washington
- Dissertation: Simulation of a Multi-Station System of Queues with Delayed Exponential Service. (Under the direction of Robert James Monroe).
- Gary Alan Massel, Physics (July, 1967)
Greensboro, North Carolina
- Dissertation: The Kinetic Theory of Forced Oscillations in Plasmas. (Under the direction of Marc R. Feix and Grover Cleveland Cobb, Jr.).
- Thomas Joseph Monaco, Crop Science (January, 1968)
Kearny, New Jersey
- Dissertation: The Partitioning and Distribution of Simazine and Propanil in Spinach Chloroplasts. (Under the direction of Donald Edwin Moreland).
- Edward Samuel Oberhofer, Physics (January, 1968)
Winston-Salem, North Carolina
- Dissertation: An Investigation of Isomeric Transitions Following the Decay of ^{227}Np , ^{241}Am , and ^{243}Am . (Under the direction of Arthur Walter Waltner).

- Lynn McIver Perry, Jr., Applied Mathematics (August, 1967)
 Sanford, North Carolina
- Dissertation: Unitary Convolution Subalgebras of Incidence Algebras. (Under the direction of Kwangil Koh).
- Anco Luning Prak, Wood Technology (January, 1968)
 Raleigh, North Carolina
- Dissertation: Unsteady-State Gas Permeability of Wood. (Under the direction of Alfred J. Stamm).
- Charles Ian Maxwell Reekie, Economics (August, 1967)
 Manchester, England
- Dissertation: Some Aspects of Foreign Demand for United States Wheat. (Under the direction of Paul Reynolds Johnson).
- James Robert Reynolds, Mechanical Engineering (July, 1967)
 Boone, North Carolina
- Dissertation: Transport Processes in Magnetosolidmechanics. (Under the direction of Munir Ridha El-Saden).
- Larry Herbert Royster, Engineering Mechanics (January, 1968)
 Durham, North Carolina
- Dissertation: Investigation of the Basic Design Principles of the Flexensional Underwater Acoustic Transducer. (Under the direction of Franklin Delano Hart).
- Ernest Davis Seneca, Botany (July, 1967)
 Virginia Beach, Virginia
- Dissertation: Seed Germination and Seedling Development of Four Dune Grasses from the Outer Banks of North Carolina. (Under the direction of Arthur Wells Cooper).
- William Hutton Sides, Jr., Nuclear Engineering (January, 1968)
 Greensboro, North Carolina
- Dissertation: An On-Line Auto- and Cross-Correlator for Nuclear Reactor Noise Analysis. (Under the direction of Raymond Frederick Saxe).
- Tejinder Harpal Singh, Genetics (January, 1968)
 Ludhiana District, Punjab, India
- Dissertation: Comparison of Vigor in Serial Backcross Generations and Their Selfed Progenies Derived from *Hirsutum* x *Barbadense* Hybrids in *Gossypium*. (Under the direction of Stanley George Stephens).
- Ronald Ellis Smith, Civil Engineering (January, 1968)
 Rocky Mount, North Carolina
- Dissertation: A Study of Consolidation of Cohesive Soils Under Constant Rates of Strain. (Under the direction of Harvey Edward Wahls).
- Robert Seago Sowell, Biological and Agricultural Engineering (July, 1967)
 Coldwater, Mississippi
- Dissertation: A Farm Machinery Replacement Study with Application to the Replacement of Self-propelled Cotton Pickers. (Under the direction of David Alan Link).
- Asham Sultan Sulaiman, Forestry (January, 1968)
 Baghdad, Iraq
- Dissertation: A Study of Desiccation and Effects of Antidesiccants on Water Loss Through the Foliage and Bark of Five Species of Hardwood Planting Stock. (Under the direction of T. Ewald Maki).

- Bence Frank Swindel, Forestry (January, 1968)
Athens, Georgia
- Dissertation: On the Estimation of Forest Growth Parameters in a Linear Model with Correlated Errors. (Under the direction of T. Ewald Maki and Robert James Monroe).
- Ruen Chiu Tang, Wood Technology (January, 1968)
Taichung, Taiwan, China
- Dissertation: Boundary Value Problems in Anisotropic Elasticity. (Under the direction of Benjamin Anderson Jayne).
- James Lamar Teate, Forestry (August, 1967)
Cordele, Georgia
- Dissertation: Some Effects of Environmental Modification on Vegetation and Tree Growth in a North Carolina Pocosin. (Under the direction of T. Ewald Maki).
- David Lee Terry, Soil Science (January, 1968)
Burkley, Kentucky
- Dissertation: Quantitative Prediction of Leaching in Field Soils. (Under the direction of Charles Bernard McCants).
- Ewell Douglas Waits, Botany (August, 1967)
Birmingham, Alabama
- Dissertation: Net Primary Productivity of an Irregularly-Flooded North Carolina Salt Marsh. (Under the direction of Arthur Wells Cooper).
- Robert Henry Wakefield, Jr., Physics (January, 1968)
Salisbury, North Carolina
- Dissertation: Nuclear Magnetic Double Resonance of Complex Spin Systems (Under the direction of Jasper Durham Memory).
- William Jean Wilhelm, Civil Engineering (January, 1968)
Mobile, Alabama
- Dissertation: An Analytical Study of the Effect of Creep and Shrinkage on the Behavior and Ultimate Capacity of Long Hinged Prestressed Concrete Columns. (Under the direction of Paul Zung-teh Zia and Mehmet Ensar Uyanik).

Recipients of Honorary Degrees

RALPH WALDO CUMMINGS

The whole meaning of a university is embedded in the name of RALPH WALDO CUMMINGS, a distinguished agricultural scientist whose name also calls up the memory of the first great American philosopher. A native of North Carolina and graduate, in 1933, of this institution, Dr. Cummings has devoted a brilliant career to the advancement of soil technology. In 1942 he was named head of North Carolina State University's Department of Agronomy, continuing in that position until 1950, when he became Director of the North Carolina Agricultural Experiment Station. In this capacity, he played a major part in launching our Agricultural Research Mission to Peru, a foreign assistance program now generally regarded as one of the most successful every developed by an American university. In 1957, however, destiny saw to it that, like his transcendentalist namesake, Ralph Waldo Cummings would turn toward India. As field director of the Indian Agricultural Program for the Rockefeller Foundation he was, until 1966, a resident of New Delhi, where his accomplishments can best be expressed in these words from a tribute paid to him by the faculty and students of the Indian Agricultural Research Institute: "With great practical wisdom and emphasis on realistic possibilities, you made the core of (our) programme the concept of making the maximum use of existing resources, a philosophy which is profoundly relevant to countries like ours which are often short of materials and equipment. This philosophy, put into practice with quiet thoroughness, has had a striking impact on Indian agriculture in the short space of nine years, both in terms of the productivity of agriculture and of the evolution of new patterns of research."

Ralph Waldo Emerson called for men to live vitally and usefully in the present. Ralph Waldo Cummings, distinguished student, teacher, scientist, and administrator, now Associate Director for Agricultural Sciences of the Rockefeller Foundation, has given Emerson's ideal the weight of reality.

GEORGE MAURICE HILL

There is hardly a facet of public service to which GEORGE MAURICE HILL has not made a valuable contribution, whether as a member of the board of deacons of his church, administrative officer of the consolidated University of North Carolina, Chairman of the Board of Trustees of Wake Forest University, trustee of Western Piedmont Community College, or member and immediate past chairman of the board of the North Carolina State Engineering Foundation. He was the first chairman of the Engineering School Advisory Council when it was organized in 1953. Maurice Hill has served as Counselor to our School of Forest Resources. These are but a few items in a list of accomplishments so impressive in generosity and substance that it seems almost an afterthought to add that he has been President of Drexel Furniture Company and, since 1965, President of the parent corporation, Drexel Enterprises, Inc. Putting aside a wayward thought that his preoccupation with desks, chairs and board tables has made this furniture manufacturer his own best consumer, we instead gratefully recognize that he has been especially generous in his concern for this institution.

A native of Rutherford County, Maurice Hill has been characterized by one of his associates as a "driver and a doer" and, in the same breath, as "a charming and considerate man." This rare combination of qualities may explain a career that has encompassed both the great and the small: major industrial enterprises and universities on the one hand, church committees and local school systems on the other. His career has been, above all, a manifestation of his deep concern for the moral and intellectual health of the state and region.

WILLIS KING

Currently Chief of the Division of Fishery Services of the Bureau of Sport Fisheries and Wildlife, United States Department of the Interior, DR. WILLIS KING has dedicated a long and fruitful career in biological science to the management of wildlife resources. A native of Ohio, Dr. King has been particularly active in promoting the improvement of sport and commercial fishing in the southeastern United States. His influence has often been felt on this campus, starting in 1940 when he began a nine-year residence in Raleigh, and a close association with our Zoology Department, while Chief of Fisheries for the North Carolina Wildlife Resources Commission. In that period and in the years since, Dr. King's relations with North Carolina State University have included a charter membership in our chapter of the Society of Sigma Xi, and the establishment of one of the early Cooperative Fishery Units at this institution. He has been equally helpful to the state as a whole. From 1955 to 1959, Dr. King served as chairman of the Roanoke River Steering Committee, which coordinated the efforts of several state and federal agencies in a study of this river and its fishery resources. Perhaps the most unusual project of Willis King's career has been a program of providing technical assistance on fishery management to Indian tribes. Among the beneficiaries of this humane application of technology have been the Eastern Band of Cherokees on the Cherokee Indian Reservation in North Carolina. Productive scholar, able administrator, possessed of a rare understanding of campus and government, Willis King exemplifies science in the service of man.

NELLO LEGUY TEER, JR.

If we observe that the history of the construction industry in North Carolina has been largely a matter of blood, sweat and Teers, we may expect to be forgiven only if we hastily add that today we are proud to honor the foremost of the Teers. A native of Durham, a graduate of the University at Chapel Hill, NELLO LEGUY TEER, JR. in 1959 assumed the presidency of the company bearing his father's name. The operations of his firm extend far beyond the boundaries of this state into other regions of America and other nations of the world; the eminence of the Nello L. Teer Company alone would provide reason enough for our institution to confer an honorary degree upon this engineer-businessman. In addition to his successful career, however, and to a great variety of public services, Nello Teer has been a friend to higher education and to this institution in particular. Among numerous formal activities which can be cited are his services to the Engineering Foundation beginning in 1956 and continuing to the present, including a two-year term as president of the Foundation from 1963 to 1965. In 1947, he headed a drive to establish the Frank Page Professorship in Civil Engineering; the Teer Company made the first contribution to this fund. Nello L. Teer, Jr., in the words of an observer, "exemplifies the best in business and construction leadership and in responsible citizenship in his community and state. The industry, the school and North Carolina are all better for his unselfish public service."

Awards For Achievement 1967-1968

SCHOOL OF AGRICULTURE AND LIFE SCIENCES

Agricultural Council Outstanding Club Member Awards:

Agronomy: Henry Bryant Hagwood, Raleigh

Horticulture: Elwood Lee Cumbo, New Bern

Wildlife Biology: John Kent Crawford, North Wilkesboro

Agricultural Engineering: Roy Dean Rhue, Winston-Salem

Agricultural Economics: Charles E. Daniel, Jr., Sanford

Agricultural Institute: Nancy Charles Holt, Star

Food Science: John Robert Woodard, Jr., Spring Hope

Animal Science: Lary Wayne Stewart, Elkin

Poultry Science: Harlen James Price, Jr., Monroe

Pre-Veterinary: Louis G. Harrelson, Waco

Agricultural Economics:

Wall Street Journal Achievement Award: Thomas McKenzie Crews, Jr., Raleigh

Agronomy:

Senior Highest Scholastic Average in Agronomy: Ronald Perry Thompson, Lucama (Plant Protection)

American Society of Agronomy Award, Most Outstanding Senior: Ronald Perry Thompson, Lucama (Plant Protection)

Agronomy Club Leadership Award: Henry Bryant Hagwood, Raleigh (Agronomy)

Agronomy Achievement Award: Carl Wells Hall, III, Mt. Ulla (Agronomy)

Animal Science:

American Society of Animal Science Senior Scholarship Award: John V. Hall, Aulander; Aubrey W. Garner, Roanoke Rapids

Biological and Agricultural Engineering:

American Society of Agricultural Engineers, Student Honor Awards: Jed Repass Newland, Raleigh

Senior Honor Award in Biological and Agricultural Engineering—Technology Program: Roy Dean Rhue, Winston-Salem

Food Science:

Virginia Dare Award: Margaret Anne Cooke, Cleveland

Forbes Chocolate Award: Robert Lionel Stark, Raleigh

Ambrosia Chocolate Award: John Robert Woodard, Jr., Spring Hope

Gamma Sigma Delta:

Sophomore Certificate: Brian K. Ashford, Belhaven (Animal Science)

Senior Certificate: Robert Ray Jackson, Pittsboro (Biological Sciences)

Horticultural Science:

Burpee Award: John C. Webster, Statesville

Outstanding Senior Award: Elwood Lee Cumbo, New Bern

Pre-Veterinary:

Outstanding Student: Lewis G. Harrelson, Waco

Zoology:

Most Outstanding Student: David Allen Pennell, Boomer

SCHOOL OF DESIGN

North Carolina Section of the Southeastern Chapter of the American Society of Landscape Architects Book Award: Randolph Thompson Hester, Roxboro

The American Society of Landscape Architects Certificate of Merit: Randolph Thompson Hester, Roxboro; Donald Lynn Collins, Charlotte

The Industrial Designers Society of America Certificate of Merit: Philip Warren Cotton, Roanoke, Virginia

The Alcoa Book Award: Lewis Franklin Bost, Shelby

The American Institute of Architects School Medal: Reinhard Karl Goethert, Manchester, Tennessee

The American Institute of Architects Book Award: Richard John Green, Plainesville, Ohio

Alpha Rho Chi Medal: James Hassell Ross, Jr., Raleigh

North Carolina Chapter of The American Institute of Architects Book Award: Reinhard Karl Goethert, Manchester, Tennessee

Walter Hook Award: Margaret Marie Garey, Easton, Maryland

SCHOOL OF EDUCATION

Education Council Key, most outstanding student enrolled in: Agricultural Education, Reuben Richard French, Jr., Draper; Industrial and Technical Education, Elbert Ronald Batten, Clayton; Mathematics and Science Education, Jane Cornwell Warren, Lincolnton

Agricultural Education Club Award: most outstanding senior graduating at the end of the fall semester, Alton Phil Grady, Selma; graduating at the end of the spring semester, Reuben Richard French, Jr., Draper

Kappa Phi Kappa Scholarship Medal: Elbert Ronald Batten, Clayton

SCHOOL OF ENGINEERING

Dean's Leadership Award: James C. Henderson, Hendersonville (Senior, Chemical Engineering)

The Hamilton Watch Award: Lonnie L. Miller, Raleigh (Senior, Industrial Engineering)

The Outstanding Engineering Senior Award: David F. Parker, Rocky Mount (Senior, Industrial Engineering)

The Outstanding Engineering Citizen Award: Charles G. Letchworth, Rocky Mount (Senior, Mechanical Engineering)

Agricultural Engineering: American Society of Agricultural Engineers Student Honor Award: Jed Repass Newland, Raleigh

Chemical Engineering: American Institute of Chemical Engineers Outstanding Senior Award: Ronald James Baer, Statesville; Richard Palmer Kitson, Wilmington, Delaware

Civil Engineering: American Society of Civil Engineers Award to Outstanding Seniors: John Royster Armfield, Mount Airy; William Wirt Payne, Jr., Blacksburg, Virginia; Douglas Lee Quinn, Wilmington; William Frank Rosser, Sanford; Associated General Contractors Award to Outstanding Senior in Civil Engineering Construction Option: Gary H. Hodges, Whiteville; North Carolina Chapter of the American Public Works Association Award to Outstanding Seniors in Civil Engineering: William H. Harris, Fredericksburg, Virginia; William H. Lockhart, Charlotte

Electrical Engineering: Outstanding Senior Award: Joseph Sampson Colson, Oxford; Institute of Electrical and Electronics Outstanding Student Award: Everette Allen Barefoot, Jr., Cary

Engineering Mechanics: Comma-Dot-Eye Award: Bradley Wayne Smith, Chapel Hill

Engineering Operations: Outstanding Senior Award: William Sidney Horton, Jr., Charlotte

Industrial Engineering: Outstanding Senior Award: David Franklin Parker, Jr., Rocky Mount

Mechanical Engineering: American Institute of Aeronautics and Astronautics Outstanding Achievement Award: Ronald W. Shoulars, Kinston; American Institute of Aeronautics and Astronautics Chairman's Certificate: Samuel T. Hicks, Wake Forest; American Society of Mechanical Engineers Certificate Award: Charles Joseph McCann, Rockville, Maryland; Pi Tau Sigma Award: George Atlas Corbett, Ayden

Mineral Industries: Mineral Industries Achievement Award: Michael Kent Lee, Monroe

Nuclear Engineering: Outstanding Nuclear Engineering Senior: Richard James Hosey, Raleigh

SCHOOL OF FOREST RESOURCES

Xi Sigma Pi Senior Award: James P. Cunningham, Durham

Xi Sigma Pi Freshman Award: Clarence A. Dykes, Savannah, Georgia

Continental Can Competitive Scholarship Awards: John David Harper, Raleigh; James Victor Henderson, Hopewell, Virginia; William R. Norton, Danville, Virginia; Andrew Stewart Nuckols, Rocky Mount; George Daniel Shankle, Jr., Polkton

Homelite Honor Awards: George G. Glass, Jr., Raleigh; Albert Coffey, Blowing Rock; Henry Smith, Raleigh; Marc L. Staff, New York, New York

Biltmore Scholarship Awards: George S. Crum, Charlotte; Carl W. Houston, Clearwater, Florida; Howard C. Williams, Jr., Winston-Salem

Conger Scholarship Awards: Edmond J. Goforth, Jr., Marshall; Thomas W. Hardison, New Bern

Rho Phi Alpha Award: Robert S. Stokes, Haddonfield, New Jersey

Paper Industry Management Association Award: Harold E. Sellers, Westport, Connecticut

French Broad River Garden Club Scholarship Award: John M. Whisenant, Morganton

Crown Zellerbach Scholarship Awards: Johnnie D. Respass, Plymouth; Mack William Bailey, Andrews, South Carolina

Weyerhaeuser Fellowship Awards: Myron W. Kelly, Lysander, New York; Stephen R. Webster, Rochester, Washington

SCHOOL OF LIBERAL ARTS

Liberal Arts Council Scholarship Award: Edward William Fisk, North Rose, New York (Senior, Economics)

B. F. Brown Award for Excellence in Liberal Arts: Gayle Andrews Taylor, Emmaus, Pennsylvania (Senior, Psychology)

Liberal Arts Council Service Awards: Thomas Michael Antone, Raleigh (Senior, English); Bettina Lee Warthen, Raleigh (Senior, English)

SCHOOL OF PHYSICAL SCIENCES AND APPLIED MATHEMATICS

Award to Top Ranking Candidate for Degree of Doctor of Philosophy in Applied Mathematics: Kenneth Alfred Byrd, Erwin

Awards for Outstanding Ph.D. Work: Stephen Hunt Brown, Raleigh; Noal Cope Harbertson, Raleigh; Gary Douglas Richardson, Raleigh

Award to Outstanding Senior Candidate for Degree of Bachelor of Science in Applied Mathematics: Joseph Wayne Pace, Spring Hope

The Chemical Rubber Company Award for Outstanding Achievement in Freshman Chemistry: Paul Brent Ferrell, Raleigh

The Merck Index Award for Scholastic Achievement in Chemistry: Dale Alan Newton, Henderson

SCHOOL OF TEXTILES

American Association of Textile Chemists and Colorists Award: Michael Way Bernhardt, Salisbury

American Association for Textile Technology Award: Walter Howard Wilkinson, Hickory

Harry Ball Award: Charles Patterson Logan, Mooresboro

Delta Kappa Phi Fraternity Award: Steve Franklin Warren, Stanley

Saul F. Dribben Memorial Award: Roy Leon Lynam, Wake Forest

Everett C. Drake Award: Louie Grayson Carter, Winston-Salem

Alfred Hofmann Needle Works Award: Steve Allen Bolick, Hickory

Iacona Cooper Sales Corporation Award: David Timothy Rouse, La Grange

Lawrence Iason Award: Robert Edward Dalton, Raleigh

North Carolina Textile Manufacturers Association Award: Steve Franklin Warren, Stanley

Phi Psi Fraternity Award: Clifton Wayne Cook, Winston-Salem

John M. Reeves Scholarship: Rodney Lloyd Goldwell, Southboro, Massachusetts

Harry Riemer Award: John Nance Hall, Elkin

Chester H. Roth Award: Richard Erik Jenkins, Concord

Sigma Tau Sigma Scholarship Fraternity Award: James R. Simpson, Concord

Textile Forum Technical Journalism Award: Mike Howle, Burlington

Textile Forum Technical Journalism Award: Ted E. Hunevutt, Albemarle

Textile Veterans Association Award: Leslie Ray Payne, Mebane

ALUMNI ATHLETIC TROPHY

James M. Donnan, III, Burlington

PHI KAPPA PHI, NATIONAL HONORARY SCHOLARSHIP SOCIETY

Intellectual Achievement—Ph.D. Candidate: Hubert Hartman Davis, Jr., Knightdale

Intellectual Achievement—M.S. Candidate: Thomas Lynn Honeycutt, High Point

Highest Scholastic Standing—Senior: James Elmore Lowe, Pfafftown

Highest Scholastic Standing—Junior: James Edward Wilbourn, Gurley, Alabama

Highest Scholastic Standing—Sophomore: Mrs. Odile Marie Maher, Raleigh

AIR FORCE ROTC AWARDS

American Legion ROTC General Military Excellence Award: Cadet Colonel Thomas E. May, Springfield, Virginia (Gold); Cadet Captain Douglas A. Hoggard, Madison (Silver)

American Legion ROTC Scholastic Award: Cadet Colonel Keith L. Kushman, Cary (Gold); Cadet 1st Lt. James M. Howard, II, Oxford (Silver)

Armed Forces Communications and Electronics Association Award: Cadet 2nd Lt. Herman M. McCorkle, Fayetteville

Daughters of the Founders and Patriots of America Medal: Cadet Airman Robert J. McCormick, Hazlet, New Jersey

Sons of the American Revolution ROTC Medal: Cadet Airman Basic Stephen E. Dorman, Conway, South Carolina

Reserve Officers' Association Awards: Cadet Airman Basic Stephen J. Dunning, Durham; Cadet SSgt. Lanny N. Smith, Mocksville; Cadet Captain Larry W. Black, Stanfield; Cadet Lt. Col. Charles C. Sink, Winston-Salem

Air Force Association Award: Cadet Colonel Charles W. Arthur, II, Candler

Major General William C. Lee Award: Cadet Airman Basic Charles M. Craft, Portland, Oregon

Arnold Air Society Award: Cadet TSgt. Gary W. Brock, High Point

Best Drilled Air Force Cadet Award: Cadet Airman Basic John T. Duncan, Jr., Apex; Cadet TSgt. Gary W. Brock, High Point; Cadet Captain Larry W. Black, Stanfield

Flight Leader Award: Cadet SSgt. David L. Hayes, Durham
Commandant of Cadets Award: Cadet Colonel Wayne Mayfield, Jacksonville
Air Force Times Award: Cadet Lt. Col. Bascombe J. Wilson, Asheville
PAS Award: Cadet Colonel Charles W. Arthur, II, Candler
General Dynamics Award: Cadet SSgt. Robert M. Tayloe, Ahoskie

ARMY ROTC AWARDS

American Legion Medals for Military Excellence: Cadet Staff Sergeant Joseph C. McAlexander, Center Valley, Pennsylvania; Cadet Captain Jerald L. Nelson, Salt Lake City, Utah

American Legion Medals for Scholastic Excellence: Cadet Sergeant First Class Richard J. Trichter, Great Neck, New York; Cadet Captain Leon R. McLawhorn, Raleigh

Armed Forces Communication and Electronics Association Medal: Cadet Lieutenant Howard E. Poole, Glen Alpine

Daughters of the Founders and Patriots of America Medal: Cadet Jerry S. Williams, Raleigh

Sons of American Revolution Medal: Cadet First Sergeant Larry B. Hancock, Seagrove

Reserve Officers Association Certificates: Cadet Lieutenant Douglas R. Davis, Newton; Cadet David W. Shuford, Hickory; Cadet Maynard R. Stalter, Winston-Salem

Reserve Officers Association Medal: Cadet Sergeant First Class Donald P. Duncan, Franklin

Department of the Army Superior Cadet Medals: Cadet Lieutenant Colonel Charles J. Gantner, Piscataway, New Jersey; Cadet Sergeant Major Ronald W. Shuklis, Petersburg, Virginia; Cadet Charles O. Midgette, Belhaven; Cadet Robert L. Holden, Charleston Heights, South Carolina

Colonel John W. Harrelson Award: Cadet Clifford E. File, Jr., Salisbury

Army ROTC Best Drilled Platoon Award: Cadet Lieutenant Michael R. Enslev, Belmont

Professor of Military Science Award—Best Company: Cadet Captain William E. Linn, Fayetteville

Association of the United States Army Medal: Cadet Sergeant Major Joseph Wooten, Rocky Mount

Association of the United States Army Award: Cadet Wiley M. Woolard, Washington

Scabbard and Blade Awards: Cadet Sergeant Major Ronald A. Moore, Castle Hayne; Cadet Captain Calvin M. Tucker, Mayodan

Pershing Rifles Award for Pershing Rifle's Outstanding MS I: Cadet William Farmer, Wilmington

Pershing Rifles Award for Pershing Rifle's Outstanding MS II: Cadet William Etheridge, Raleigh

Pershing Rifles Award for Pershing Rifles Outstanding Advanced Course Cadet: Cadet Sergeant Major Ronald A. Moore, Castle Hayne

OUTSTANDING TEACHER AWARDS

This year the graduating seniors have selected two recipients for the outstanding teacher awards. Each award is accompanied by a \$500 check from the North Carolina State Alumni Association.

The awards are announced each year as part of the Commencement exercises.

USAF ROTC Cadets Commissioned 1967-1968

TO BE COMMISSIONED ON 25 MAY 1968:

Acree, William	Greensboro, North Carolina
Alley, Larry Michael	Kernersville, North Carolina
Anderson, Charles Edward	St. Petersburg, Florida
*Arthur, Charles Waller, II	Candler, North Carolina
Bledsoe, Samuel Black, III	Cocoa Beach, Florida
Boyles, Charles Franklin, Jr.	Charlotte, North Carolina
Chambers, Howard Burgess, Jr.	Winston-Salem, North Carolina
Cooke, Robert Joseph	Four Oaks, North Carolina
Dalton, Robert Edward	Raleigh, North Carolina
Daniska, Michael David	Bassett, Virginia
Daves, John Eugene	Asheville, North Carolina
Ellington, Johnny Emerson	Graham, North Carolina
*Fisher, Wayne Curtis	Norfolk, Virginia
Gallogly, William Francis, Jr.	Arlington, Virginia
Griswold, William Albert	Raleigh, North Carolina
Hall, William Bennett	Pineville, North Carolina
Henderson, James Chadwick	Hendersonville, North Carolina
Hughes, Charles Edward	Greensboro, North Carolina
Jones, Michael Theodore	Fayetteville, North Carolina
*Kushman, Keith Lee	Cary, North Carolina
Lamont, Raymond Arthur	Richmond, Virginia
Leonard, Joseph Edwin	Greensboro, North Carolina
Logan, Charles Patterson, Jr.	Mooresboro, North Carolina
*May, Thomas Edward	Springfield, Virginia
*Murdock, Thomas Lee	Silver Spring, Maryland
*Prone, Michael Brian	Scituate, Massachusetts
Rawls, Lloyd Hildres	Fayetteville, North Carolina
Rogers, Henry Dean, Jr.	Greensboro, North Carolina
*Setzer, Edwin Paul	Hickory, North Carolina
Shore, Thaddeus William	Boonville, North Carolina
Shoulars, Ronald Williams	Kinston, North Carolina
Sink, Charles Cramer	Winston-Salem, North Carolina
Stafford, Russell Gerald	Monroe, North Carolina
Steinberger, Alfred John, III	Charlotte, North Carolina
Tarleton, David Walter, Jr.	Mount Pleasant, North Carolina
Thaler, William Bennett	Manassas, Virginia
Turner, Donald Wilson	Raleigh, North Carolina
White, Ralph Rigidon, Jr.	Greensboro, North Carolina
White, William Wallace, Jr.	Black Mountain, North Carolina
Wicker, Harvey Lee	Raleigh, North Carolina
Willett, Donald Roy	Durham, North Carolina
Williams, David Lee	Durham, North Carolina
Wilson, Bascombe Jay	Asheville, North Carolina

COMMISSIONED ON 1 JUNE 1967-30 APRIL 1968:

Bailey, William Butler	Salisbury, North Carolina
Brown, Dale Linwood, Jr.	Omaha, Nebraska
Caldwell, James	Suffern, New York

* Distinguished Graduate

Chagaris, Robert Leon	New Bern, North Carolina
Coltrain, Frederick Thayer	Oak City, North Carolina
Daniel, Howard Wayne	Greensboro, North Carolina
Daniels, Roger Glenn	Oak City, North Carolina
Dickey, John William, Jr.	High Point, North Carolina
•Duncan, Farris Allen	Timberlake, North Carolina
Ellen, John Maigrit	Winston-Salem, North Carolina
Gardner, Donald Rex	Clayton, North Carolina
Grigg, Don Alfred	Charlotte, North Carolina
Haas, Milton Frank	Fayetteville, North Carolina
Lauppe, Thomas Pinckney	Charlotte, North Carolina
Livera, Aldo Leon, Jr.	Madison, New Jersey
Mikeal, Jerry Houck	Charlotte, North Carolina
Moran, Michael Julius	New Bern, North Carolina
Morgan, John Glendon	Mount Holly, North Carolina
Murphy, Herbert Stetser, Jr.	Moorestown, New Jersey
•Pfefferkton, James Winans	Winston-Salem, North Carolina
Ruehrwein, William Raymond, Jr.	Cincinnati, Ohio
Sparks, Terry Grant	Winston-Salem, North Carolina
Tart, Howard Gale	Dunn, North Carolina
Whitley, Russell Vernon	Durham, North Carolina
Whitley, Willard Hugh	Selma, North Carolina
Willard, Thomas Vann	Raleigh, North Carolina
Wise, Chesley Gerald, Jr.	Raleigh, North Carolina

• Distinguished Graduate

Army ROTC Cadets Commissioned 1967-1968

TO BE COMMISSIONED ON 25 MAY 1968:

Austin, Michael R.	Marshville, North Carolina
Averette, Henry P., Jr.	Raleigh, North Carolina
Baker, Jerry B.	Greensboro, North Carolina
Bost, Jonathan W.	Kings Mountain, North Carolina
Brake, Joseph A.	Rocky Mount, North Carolina
Chastant, Thomas J.	Raleigh, North Carolina
Cleary, Timothy M.	Southern Pines, North Carolina
Clendenin, George M.	Wilmington, North Carolina
Croxton, Randolph R.	Burlington, North Carolina
Eagar, Harry D., Jr.	Virginia Beach, Virginia
Ensley, Michael R.	Belmont, North Carolina
*Frick, Grady J.	Albemarle, North Carolina
*Gantner, Charles J., Jr.	Piscataway, New Jersey
Hayes, Jerry G.	Selma, North Carolina
Hays, Davis E.	Kinston, North Carolina
*Hough, Amos J., Jr.	Wingate, North Carolina
Ipock, Charles E.	Vanceboro, North Carolina
Jenkins, Harvey E.	Cramerton, North Carolina
Joseph, Richard P.	New Bern, North Carolina
*Kernodle, Joseph W.	Reidsville, North Carolina
Lamb, James M.	Kinston, North Carolina
Little, Porter C., III	Pittstown, New Jersey
Lloyd, George V. B.	Raleigh, North Carolina
Maddy, Lynn G., Jr.	Raleigh, North Carolina
Martin, Edward L., Jr.	Raleigh, North Carolina
McDougall, Frank H.	Fayetteville, North Carolina
McMichael, Curtis A.	Macon, Georgia
Merrell, Carroll D.	Charlotte, North Carolina
Mitchiner, Dwane R.	Garner, North Carolina
*Montgomery, David B.	High Point, North Carolina
*Nelson, Jerald L.	Salt Lake City, Utah
*Personette, Joseph R.	Vienna, Virginia
Ross, Roger L.	Norwood, North Carolina
Sawyer, Douglas A.	Raleigh, North Carolina
Sellers, Harold E.	Mexico 5, D. F.
Sigmon, Ross M., III	Burlington, North Carolina
Summerlin, Richard W.	Albemarle, North Carolina
*Tracy, Lawrence D.	Chapel Hill, North Carolina
Turlington, James E.	Clinton, North Carolina
Van Note, Frank R.	Ashbury Park, New Jersey
*West, Thomas E., Jr.	Raleigh, North Carolina
White, Joseph H.	High Point, North Carolina
Whitehurst, Claude A.	Elizabeth City, North Carolina
Wilson, John C., III	Arlington, Virginia
York, Joseph N.	Mount Airy, North Carolina
York, Ronald C.	Charlotte, North Carolina

* Denotes Distinguished Military Student

COMMISSIONED DURING PERIOD 1 JUNE 1967-MAY 1968:

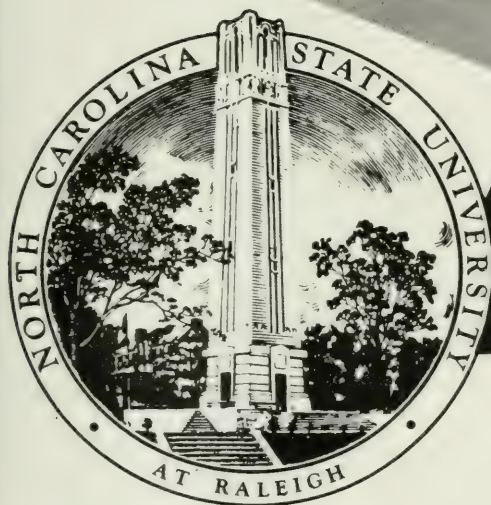
Bartelme, John W.	Whitehouse Station, New Jersey
Benson, William A.	Charlotte, North Carolina
Bohrer, Charles H.	Statesville, North Carolina
Bordeaux, Marshall N.	Ingold, North Carolina
Boyd, Charles E.	Asheville, North Carolina
Burson, Donald A.	Hendersonville, North Carolina
Claude, Willis R., II	Halifax, North Carolina
Chiswell, Alfred G., Jr.	Cary, North Carolina
Davis, Robert H.	West Jefferson, North Carolina
Davis, Virgil W.	Norfolk, Virginia
*Dixon, Gurney L.	Mount Airy, Maryland
*Doerr, John A.	Raleigh, North Carolina
Edwards, Larry R.	Salisbury, North Carolina
Ellington, Frederick H.	Zebulon, North Carolina
Ellis, Randolph W.	Fort Leavenworth, Kansas
Fisher, Vance E., Jr.	Durham, North Carolina
Forbes, Tran L.	Shawboro, North Carolina
Fussell, David Grady	Belhaven, North Carolina
*Fuzy, Eugene A.	Hopewell, Virginia
Hamilton, Douglas L.	Pine Bluff, Arkansas
Heilig, Paul T.	Salisbury, North Carolina
*Hill, Grover C., Jr.	Beulaville, North Carolina
Hodgdon, Raymond F., III	Flushing, New York
Hughes, Emmett F., Jr.	Henderson, North Carolina
Kerley, Dennils L.	Durham, North Carolina
King, Julian W.	Kinston, North Carolina
Koszewski, Christopher	Charlotte, North Carolina
Leonard, Wendell H., Jr.	Danville, Virginia
Lewis, Albert V., Jr.	Farmville, North Carolina
Marsh, Schappi	Raleigh, North Carolina
Martin, Marvin R.	Salisbury, North Carolina
Meador, Richard E.	Greensboro, North Carolina
Newsom, James L., Jr.	Durham, North Carolina
Parsons, James F.	West Jefferson, North Carolina
Sheek, James K., III	Mocksville, North Carolina
Simpson, Jerry E.	Beulaville, North Carolina
Smale, Robert E.	Falls Church, Virginia
Smith, Wister G.	Liberty, North Carolina
Strupe, Eugene F., Jr.	Tobaccoville, North Carolina
Thomas, Jesse G.	Bethel, North Carolina
Thompson, Robert B.	Lumberton, North Carolina
Wheless, Richard W.	Raleigh, North Carolina
*Wirth, Ronald L.	Raleigh, North Carolina
Wolff, Charles S.	Raleigh, North Carolina

* Denotes Distinguished Military Student

NORTH CAROLINA

Agricultural Institute

SEVENTH COMMENCEMENT



Erdahl-Cloyd Memorial Union

May 24, 1968

SEVENTH
AGRICULTURAL INSTITUTE
GRADUATION

May 24, 1968
2:00 p.m.

PROCESSIONAL

INVOCATION Reverend Edward T. Mickey
Moravian Chaplain to Students
North Carolina State University

ADDRESS Dr. George W. Smith
Associate Director
Agricultural Extension Service
North Carolina State University

AWARDING OF DIPLOMAS Dr. H. Brooks James
Dean of the School of Agriculture & Life Sciences
North Carolina State University

REMARKS Chancellor John T. Caldwell

BENEDICTION Reverend Edward T. Mickey

RECESSIONAL

* * * * *

Reception immediately following the graduation ceremony
in the South Ballroom of the Erdahl-Cloyd Union.

AGRICULTURAL INSTITUTE

GRADUATES

May 24, 1968

FARM EQUIPMENT SALES AND SERVICE

- / Michael Hocutt Alford
- * / Billy Joe Boyette
- William Fletcher Burgess, Jr.
- James Thomas Crabtree
- Donald Ray Hester
- Weldon Wallace Johnson
- / James David Long
- David Thomas McCain
- * / Howard Reed McLam
- Bobby Lawrence Moffitt
- Adam Clark Oliver, Jr.
- James Michael Reynolds
- Clinton McBride Thompson
- * Carl Reid Walker
- / Julian David Waller

FIELD CROPS TECHNOLOGY

- Robert Henry Gay, Jr.
- Earl Dwight Grimes
- Frederick Thomas Hardison
- / Charles Ryon Harper
- Charles Linwood Hayes
- * Charles Clyde Jones
- * Jerry Lee Lassiter
- Joe Francis Poindexter
- Martin Alvin Robertson, Jr.
- John Alderson Tankard, Jr.
- * Paul Herman Thompson, Jr.
- / Arthur William Turner, Jr.
- / Kenneth Edward Warren
- Milton R. Williams, II

GENERAL AGRICULTURE

- Thomas Alvah Ashley
- Alton Tharse Batten
- Hiller Fahey Byrum, Jr.
- / James West Cox
- Bobby Blake Daughtry
- Ronald Wayne Goswick
- * Frank Bell Markham
- Carl Sidney Scott
- Abner Wayne Staples
- Johnnie Martin Temple
- Charles Wells Wainright
- Donald Claude Whitmore

LIVESTOCK MANAGEMENT AND TECHNOLOGY

- Colon Douglas Burke
- Edwin James Gilchrist
- * Luke Henry Hobbs
- Franklin Rudolph Hooks, Jr.
- Mark Lantham Latta

Charles Smith Lutterloh
Rodger Edward McDowell
Norman Leslie McIver
William Harold McLaughlin, Jr.
David Richard Smith, Jr.

ORNAMENTAL CROPS TECHNOLOGY

- * Dewey Earl Croom, Jr.
- Nancy Charles Holt
- Marvin Perry Lively
- Billy Eugene Suggs
- Maurice Eugene Truelove
- Ginger Lee Turner

PEST CONTROL

- Gary Travis Almond
- Ralph Wilmot Haddock
- Roger Barry Horner
- / Donald Reid Joyce
- * Thomas Ronald McDonald
- Ronnie B. Matthews
- James Thomas Perry
- * Bobby Lawrence Prince
- * William Ervin White

SOIL TECHNOLOGY

- Ferrell Allen Berry
- Terry Frank Dover
- Carroll Lee Hyatt
- / Thomas Edward Newton
- * Albert Roy Shaw
- * J. Everett White

DUAL MAJORS

- * Jimmy Allen Benson
- Kent Lee Coble
- Richard Junior Cook
- * Leon Edwin Crouch
- / Wallace Lunsford Currin
- * Edward Allen Greer
- * Paul George Hatley
- * William Ray Hawkins
- / Jack Davis Jones
- Keith Ryker Langdon
- * Billy Carr Lockamy
- * Emanuel Allen May
- * James Abner Miller
- John Howell Parker, Jr.
- * Samuel Parker Stephenson
- Jerry Wayne Thompson
- * / William Long Thompson
- Michael Riggs Williams
- Emory Keton York

*Honors

/In Absentia

MARSHALS

Malcolm E. Jamieson
Leon Scull Williams
Frederick Eugene Johnson
Raymond H. Moore, Jr.

George William Lloyd
Robert Edward Nuckols
Bobby Wilson Murphy
Paul W. Rogers, Jr.

1968

University
Directory

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UNIVERSITY DIRECTORY

1967-68

COLLEGE EXCHANGE 755-2011

EMERGENCY NUMBERS

Fire --- Call Raleigh Fire Department.....	832-7733
then call Physical Plant.....	2181
Emergency at night, Sundays, or holidays ---	
Call Physical Plant Security Desk.....	2181
Medical Aid --- Call Infirmary.....	2410
or Rex Hospital.....	828-6211
Accidents involving radioactive materials ---	
Call.....	2894 or 2895
or at night.....	787-2947 or 832-7372

CONTENTS

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CENTREX TELEPHONE INSTRUCTIONS

If, after reading the following instructions, you require further assistance, please dial "0" for the campus operator. To report a telephone not operating properly, dial 9114 for the Telephone Company Repair Service.

INCOMING CALLS

Direct local outside calls to campus numbers may be made by dialing 755 plus the four-digit extension number. When the number is not known, callers will receive assistance by dialing the college exchange, 755-2011.

LOCAL CALLS

To other Centrex telephones--Dial the four digit number listed in this directory.

To Raleigh telephones--Dial "9" plus the seven-digit number listed in the Raleigh Telephone Directory.

LONG DISTANCE CALLS

Long distance calls will be billed to your CENTREX telephone number. To make a direct station-to-station call, dial "9" then dial "0" and the telephone company operator will assist you.

TO TRANSFER CALLS

Remain on the line, depress the receiver plunger once for one second and release. Give the CENTREX attendant your transfer request. This applies to incoming calls from "outside" only. Other calls cannot be transferred.

DIRECTORY AND INFORMATION CHANGES

Advise the chief operator (dial "0") immediately of all personnel changes affecting CENTREX telephone numbers so that the Campus Directory and Information Service will always be current.

TELEPHONE EQUIPMENT CHANGES

The following procedure will be used for approval of orders for additions or changes in telephone equipment.

1. To secure technical information prior to submitting a request, department heads may contact the Telephone Company Business Office.
2. The department head will then prepare a letter in duplicate to the Office of Business Affairs, Attention: Mrs. Olive Stone, 116 Winston, setting forth the specific changes or additions in equipment which are desired. This letter must designate the availability and source of funds to pay for the service requested.
3. The Supervisor of Telephone Services will process the order with the Telephone Company and the Physical Plant office, after it has been determined that funds, in fact, are available to support the request.

The Office of Business Affairs insists that budget adjustments necessary to support additional telephone service be submitted and approved in writing prior to initiation of the service order to the Telephone Company.

ADMINISTRATION

THE UNIVERSITY OF NORTH CAROLINA

	Chapel Hill
President.....	William Friday.....933-1026
	NCSU Office 2849
Vice President for Public Service.....	C. E. Bishop.....933-2147
Vice President for Academic Affairs.....	William S. Wells.....933-1024
Vice President for Institutional Studies.....	Arnold K. King.....933-2130
Vice President for University Relations.....	Fred H. Weaver.....933-2131
Assistant Vice President and Treasurer.....	A. H. Shepard, Jr.....933-1035
Assistant to the President.....	Rudolph Pate.....933-2151
Escheat Officer.....	J. Sib Dorton, Jr.....933-2132

NORTH CAROLINA STATE UNIVERSITY

Chancellor.....	John T. Caldwell.....A Holladay.....2191,2192
Provost.....	Harry C. Kelly.....109 Holladay.....2195
Dean of the Graduate School...	Walter J. Peterson...104 Peele.....2871
Admn. Dean for Research.....	H. F. Robinson.....206 Daniels.....2117
Admn. Dean for Univ. Ext.....	William L. Turner...138 1911 Bldg.....2144
Dean of Student Affairs.....	James J. Stewart....101 Holladay.....2446
Business Manager.....	John D. Wright.....105 Holladay.....2155
Dir. of Foundations and Development.....	Robert W. Shoffner...12 Holladay.....2846

DEANS OF THE SCHOOLS

Agriculture and Life Sciences.....	H. Brooks James.....115 Patterson.....2613,2615
Design.....	H. L. Kamphoefner...200-B Brooks.....2201
Education.....	J. Bryant Kirkland...119 Tompkins.....2231,2232
Engineering.....	R. E. Fadum.....229 Riddick.....2312
Forest Resources.....	R. J. Preston.....162 Kilgore.....2883,2884
Liberal Arts.....	Fred V. Cahill.....162 Harrelson.....2467
Physical Sciences and Applied Mathematics.....	A. C. Menius, Jr.....115 Gen. Lab Bldg...2501,2502
Textiles.....	David W. Chaney.....101 Nelson.....2575,2576

SCHOOLS, DEPARTMENTS, DIVISIONS, OFFICES

Name, Title, Department, and Address

Office
Phone

A

Admissions		
Director.....	Kenneth D. Rabb	112 Peele.....2431
Asst. Director.....	Robert K. White	112 Peele.....2431
Adult Education		
Head.....	E. J. Boone	117 Ricks.....2707, 2819
Agricultural Education		
Head.....	C. C. Scarborough	123 Tompkins.....2234
Agricultural Experiment Station		
Head.....	R. L. Lovvorn	107 Patterson.....2717
Agricultural Information		
Acting Head.....	Tom Byrd	118 Ricks.....2800, 2804
Agricultural Institute		
Director.....	H. B. Craig	108 Patterson.....2667
Agricultural Policy Institute		
Director.....	James G. Maddox	220 Patterson.....2608
Agriculture and Life Sciences, School of		
Dean.....	H. Brooks James	115 Patterson.....2613, 2615
Admn. Officer.....		120-G Patterson.....2716
Agricultural Extension Service		
Director.....	George Hyatt, Jr.	104 Ricks.....2812
Assoc. Director.....	George Smith	106 Ricks.....2812
Asst. Dir. & County		
Agent Leader.....	J. Ed Foil	108 Ricks.....2813
4-H.....	T. C. Blalock	202 Ricks.....2801
Home Economics.....	Eloise Cofer	101-A Ricks.....2781
Marketing.....	J. C. Williamson	112 Ricks.....2814
Instruction Division		
Director.....	E. W. Glazener	111 Patterson.....2614
Asst. Director.....	H. B. Craig	108 Patterson.....2667
Placement Office.....	Ron Shearon	112 Patterson.....2668
Research (Experiment Station)		
Director.....	R. L. Lovvorn	107 Patterson.....2717
Animal Research.....	H. A. Stewart	109 Patterson.....2719
Biological Sciences.....	J. L. Apple	101 Patterson.....2665
Marketing.....	J. C. Williamson, Jr.	112 Ricks.....2814
Research Stations.....	C. D. Thomas	N.C. Dept. of Agri....829-3236
Tobacco.....	K. R. Keller	104 Patterson.....2718
Agromeck		
Editor.....	Harry Eagar	King Rel.Center.....2409
Air Force ROTC.....	Col.S.C.Schlitzkus	145 Coliseum.....2417
Alumni Affairs Office		
Director.....	Bryce R. Younts	103 Alumni Bldg.....2869
Asst. Director.....	David Huffman	Alumni Bldg.....2860
Animal Science		
Head.....	I. D. Porterfield	123 Polk.....2755, 2756
Animal Breeding Sect.....	J. E. Legates	231 Polk.....2768
Animal Disease Sect.....	E. G. Batte	127 An.Disease Lab.....2738
Animal Husb. Sect.....	E. R. Barrick	218 Polk.....2763
Ext. Animal Husb.....	A. V. Allen	116 Polk.....2761, 2762
Bull Barn		3532 Western Blvd.....2688
Central Station Farm		3616 Western Blvd.....2713
Nutritional Biochemistry.....	J. M. Leatherwood	318 Polk.....2773
Reproductive Physiology		
Research Lab		
		Rt. 8, Box 1110
		Blue Ridge Rd.....2673

Name, Title, Department, and Address

Office Phone

Architecture		
Head.....	Robert P. Burns, Jr.	303 Brooks.....2204
Archives.....	Maurice S. Toler	216 Library.....2273
Army ROTC.....	Col. Paul V. Tuttle	154 Coliseum.....2428
Art Service.....	James Alberg	313 Ricks.....2807
Athletics Department		
Director.....	Roy B. Clogston	105 Coliseum.....2101
Baseball.....	Sam Esposito	Carmichael.....2101
Basketball.....	Norman L. Sloan	106 Coliseum.....2103
Football.....	Earle L. Edwards	115 Coliseum.....2103
Golf.....	Albert P. Michaels	115 Coliseum.....2103
Rifle.....	Sgt. Allen Vestal	154 Coliseum.....2427
Soccer.....	Max Rhodes	Carmichael.....2487
Sports Information Dir...	J. Frank Weedon	124 Coliseum.....2102
Swimming.....	Willis R. Casey	122 Coliseum.....2101
Tennis.....	Ernie Spiller	Carmichael.....2487
Track.....	Paul Derr	Carmichael.....2486
Wolfpack Club Dir.....	Warren Carroll	104 Coliseum.....2112
Attendance Officer.....	Roderick W. Bradley	204 Peele.....2441
Auditor (Internal).....	James A. Weathers, Jr.	207 Holladay.....2158

B

Bindery (See Print Shop)		
Biochemistry		
Head.....	Gennard Matrone	339 Polk.....2581
Biological and Agricultural Engineering		
Head.....	F. J. Hassler	100 Bio. & Agri. Engr. Bldg. 2694
Ext. Bio. & Agri. Engr.....	H. M. Ellis	200 Bio. & Agri. Engr. Bldg. 2735
Biological Sciences Institute		
Director.....	J. L. Apple	101 Patterson.....2665
Book Store.....	C. L. Chambers	SSS Bldg.....2161
Botany		
Head.....	G. R. Noggle	2214 Gardner.....2727
Budget and Accounting		
Director.....	G. L. Worsley	105 Holladay.....2175
Buildings Superintendent....	George F. Lynch	4 Park Shops.....2181
Business Affairs, Office of		
Business Manager.....	John D. Wright	105 Holladay.....2155
Asst. Business Manager...	Ernest E. Durham	9 Holladay.....2146

C

Cafeterias		
Erdahl-Cloyd Union.....	B. C. Dalrymple	Union.....2454
Harris Cafeteria.....	Harry McDougald	Leazar.....2857
Leazar Cafeteria.....	James Dorton	Leazar.....2879
Slater Food Services		
Director.....	Joe Grogan	Leazar.....2877, 2879
Snackbar Operations.....	Russell T. Uzzle	SSS Bldg.....2165
Carter Stadium.....		Carter Stadium.....2215
Cashier.....	Jerry LeGarde	B Holladay.....2129
Central Stores		
Manager.....	Joseph L. Barbour	108 Morris.....2198
Chancellor's Office		
Chancellor.....	John T. Caldwell	A Holladay.....2191, 2192
Asst. to the Chancellor...	William H. Simpson	A Holladay.....2200
Chemical Engineering		
Head.....	J. K. Ferrell	113 Riddick.....2324
Chemistry		
Head.....	Z Zimmerman Hugus	108 Withers.....2545

Name, Title, Department, and Address

Office
Phone

Civil Engineering		
Head.....	Donald L. Dean	208 Mann.....2331
Climatologist, State.....	A. V. Hardy	1-C Patterson.....2823,2824
Coastal Research Program....	Arthur W. Cooper	4213 Gardner.....2223
Coliseum, Reynolds		
Director.....	Roy B. Clogston	105 Coliseum.....2101,2106
Box Office Mgr.....	R. H. Ferrell	101 Coliseum.....2106
Concessions Mgr.....	Wiley L. Gouge	119 Coliseum.....2123
Computer Science		
Acting Head.....	Paul E. Lewis	B-1 Nelson.....2518
Computing Center		
Acting Director.....	Kevin R. Jones	8-B Nelson.....2517
Computing Center, Triangle Universities (TUCC) (See Triangle Universities Computation Center)		
Continuing Education, Div. of		
Acting Director.....	W. L. Turner	138 1911 Bldg.....2144
Associate Director.....	David B. Stansel	118 1911 Bldg.....2261,2264
Curricular Branch		
Asst. Director.....	Charles F. Kolb	133 1911 Bldg.....2264
Asst. Director.....	James I. Mason	136 1911 Bldg.....2264
Short Courses and Conferences		
Asst. Director.....	M. Eugene Starnes	121 1911 Bldg.....2261
Coordinator.....	Ned B. Broyles	123 1911 Bldg.....2261
Coordinator.....	Kelly Crump	124 1911 Bldg.....2261
Coordinator.....	Maynard E. Shields	120 1911 Bldg.....2261
Contract & Grants Officer...	Glenn Musser	10 Holladay.....2154
Counseling		
Director.....	Lyle B. Rogers	205 Peele.....2422
Asst. Director.....	G. F. Needham, Jr.	213 Peele.....2424
Craft Shop.....	C. W. Weiser	Frank Thompson Bldg....2457
Creamery.....	James I. Middleton	Basement, Polk.....2700
Crop Improvement Association		
Director.....	Foile W. McLaughlin	193 Williams.....2851
Crop Science		
Head.....	P. H. Harvey	258 Williams.....2647,2648
Extension Agronomy.....	G. L. Jones	252 Williams.....2653

D

Dairy, Central Station		3616 Western Blvd.....2680
Dairy Farm		Hillsborough St.....2674
Dairy Husbandry.....	H. A. Ramsey	232 Polk.....2766
Ext. Dairy Husbandry.....	M. E. Senger	101 Polk.....2771
Dairy Records Processing Center		
Head.....	V. H. Lytton	Leazar.....2632,2633
Design Library.....	Harrye B. Lyons	209 Brooks.....2207
Design, School of		
Dean.....	Henry L. Kamphoefner	200-B Brooks.....2201
Design Shop.....	Hubert Champion, Sr.	117 Brooks.....2204
Development Office.....	Robert W. Shoffner	12 Holladay.....2846
Dormitories		
Alexander Hall		
1st Floor.....		832-9257
2nd Floor.....		834-9746
3rd Floor.....		832-9349
Bagwell Hall		
1st Floor.....		834-9219
2nd Floor.....		832-9131
3rd Floor.....		834-9151
Becton Hall		
Basement.....		832-9261
1st Floor.....		832-9256
2nd Floor.....		832-9334
3rd Floor.....		832-9372

Name, Title, Department, and Address

Office Phone

Berry Hall	
Basement.....	832-9350
2nd Floor.....	832-9363
3rd Floor.....	832-9166
Bragaw Hall	
1st Floor (even suites).....	834-9823
1st Floor (odd suites).....	834-9712
Gold Hall	
1st Floor.....	832-9263
Lee Hall	
1st Floor.....	832-9151
1st Floor.....	832-9282
Owen Hall	
Basement.....	832-9142
1st Floor.....	832-9115
2nd Floor.....	832-9252
3rd Floor.....	834-9300
Sullivan Hall	
1st Floor.....	832-9497
1st Floor.....	832-9203
Syme Hall	
Basement.....	832-9421
1st Floor.....	832-9288
2nd Floor.....	832-9150
3rd Floor.....	832-9222
Tucker Hall	
Basement.....	832-9186
1st Floor.....	832-9388
2nd Floor.....	832-9387
3rd Floor.....	832-9323
Turlington Hall	
1st Floor.....	834-9279
2nd Floor.....	832-9297
3rd Floor.....	832-9192
Watauga Hall	
1st Floor.....	832-9447
2nd Floor.....	832-9132
3rd Floor.....	832-9211
Welch Hall	
1st Floor.....	832-9119

E

Economics

Head.....	W. D. Toussaint	121 Harrelson.....	2471
Ext. Farm Management.....	Charles Pugh	216 Patterson.....	2619
Ext. Marketing Econ.....	George Capel	220 Patterson.....	2723
Education, School of		210 Patterson.....	2602
Dean.....	J. Bryant Kirkland	119 Tompkins.....	2231, 2232
Electrical Engineering			
Head.....	George B. Hoadley	240 Daniels.....	2336
Employment Office.....	James R. Swiger	Primrose.....	2135
Employment Office			
(Part-time work).....	Mrs. Mary Usry	205 Peele.....	2421
Engineering Mechanics			
Head.....	Patrick H. McDonald	119 Riddick.....	2341
Engineering Operations			
Director.....	J. W. Joseph	331 Riddick.....	2364
Engineering Research.....	Henry B. Smith	129 Riddick.....	2345, 2346

Name, Title, Department, and Address

Office Phone

Engineering, School of		
Dean.....	Ralph E. Fadum	229 Riddick.....2312
Associate Dean,		
Academic Affairs.....	R. G. Carson	232 Riddick.....2316
Associate Dean, Research		
and Graduate Program....	Henry B. Smith	224 Riddick.....2314
Assistant Dean for		
Extension.....	John R. Canada	241 Riddick.....2310
Freshman Engr. Div.....		239 Riddick.....2319
English		
Head.....	Lodwick Hartley	120 Winston.....2464
Entomology		
Acting Head.....	Ernest Hodgson	2301 Gardner.....2746
Ext. Entomology.....	G. T. Weekman	2309 Gardner.....2703
Erdahl-Cloyd Union (See Union)		
Experimental Statistics (See Statistics)		
Extension Dean (See University Extension)		
Extension Education Institute		
Director.....	E. J. Boone	117 Ricks.....2707

F

Facilities Planning Division		
Director.....	Carroll L. Mann, Jr.	Watauga.....2121
Campus Planning		
Consultant.....	Edwin F. Harris, Jr.	Watauga.....2121
Faculty, Dean of (See Provost)		
Faculty Club		
Manager.....	Francis Leland	4200 Hillsborough...832-0308
Financial Aid		
Director.....	Charles F. George, Jr.	205 Peele.....2421
Food Science		
Head.....	W. M. Roberts	124 Polk.....2796, 2797
Ext. Food Science.....	W. M. Roberts	124 Polk.....2796, 2797
Foreign Student Advisor.....	Jon O. Heise	213 Peele.....2423
Forest Resources, School of		
Dean.....	R. J. Preston	162 Kilgore.....2883, 2884
Asst. to the Dean.....	L. C. Saylor	162 Kilgore.....2883
Forestry		
Head.....	T. E. Maki	272 Kilgore.....2885
Forestry Extension		
Director.....	Walter M. Keller	264 Kilgore.....2891
Fort Bragg Branch		
Director.....	Millard P. Burt	P.O. Box 207.....396-4111
		Fort Bragg, N.C....Ext. 60133
Foundation Seed Producers, Inc.		
Manager.....	R. W. McMillen	124 Williams.....2821
Foundations and Development		
Director.....	Robert W. Shoffner	12 Holladay.....2846
Asst. Director.....	C. W. Hart	12 Holladay.....2846
Asst. Director.....	R. N. Wood	12 Holladay.....2846
Fraternities		
Interfraternity Council		
President.....	David Biggers	208 Union.....2404
Alpha Gamma Rho.....		2304 Hillsborough...833-4545
		832-6451
Delta Sigma Phi.....		Box 5566, Tryon Rd...832-9102
FarmHouse.....		1718 Hillsborough...828-9275
Kappa Alpha.....		2601 W. Frat. Ct....834-9359
Kappa Sigma.....		2613 W. Frat. Ct....828-9177
Lambda Chi Alpha.....		108 S. Frat. Ct....832-7708
Phi Kappa Tau.....		2511 W. Frat. Ct....832-7050
Pi Kappa Alpha.....		214 S. Frat. Ct....828-9200
Pi Kappa Phi.....		2401 W. Frat. Ct....828-9303
		828-9304
		828-9305

Name, Title, Department, and Address	Office Phone	Res. Phone
Sigma Alpha Epsilon.....	2701 W. Frat. Ct....	828-9181 833-6900
Sigma Alpha Mu.....	2501 W. Frat. Ct....	833-8342
Sigma Chi.....	2409 W. Frat. Ct....	832-9148
Sigma Nu.....	204 S. Frat. Ct....	834-9726
Sigma Phi Epsilon.....	100 S. Frat. Ct....	832-9411
Sigma Pi.....	2513 Clark Ave.....	828-9136
Tau Kappa Epsilon.....	2619 W. Frat. Ct....	832-8896
Theta Chi.....	1508 Hillsborough...	832-6901
Friends of the College.....	Mrs. Margaret Marks Union.....	2452

G

Genetics		
Head.....	T. J. Mann	3515 Gardner.....2291
Nursery		Reedy Creek Rd.....2757
Geosciences		
Acting Head.....	Carlton J. Leith	210 Page.....2212
Graduate School		
Dean.....	Walter J. Peterson	104 Peele.....2871, 2872
Asst. Dean.....	Vernon E. Holt	104 Peele.....2873
Grounds Superintendent.....	Harold G. Bolick	1 Morris.....2181
Guidance and Personnel Services		
Head.....	W. E. Hopke	209 Tompkins.....2244

H

Health Service (Student)		
Director.....	Dr. Joseph J. Combs	Clark.....2410
History		
Head.....	Ralph W. Greenlaw	110 Harrelson.....2485
Home Economics Extension		
Clothing.....	Mary Em Lee	300 Ricks.....2781
Family Relations.....	Frances Jordan	206 Ricks.....2784
Food & Nutrition.....	Marjorie Donnelly	213 Ricks.....2786
Home Management.....	Thelma Hinson	209 Ricks.....2784
Housing-House		
Furnishings.....	Charlotte Womble	210 Ricks.....2785
Horticultural Science		
Head.....	Clive W. Donoho, Jr.	118 Kilgore.....2684
Ext. Horticulture.....	J. H. Harris	235 Kilgore.....2686, 2687
Housing Office		
Director.....	N. B. Watts	203 Peele.....2406
Assoc. Director.....	John T. Kanipe, Jr.	203 Peele.....2406
Asst. Director.....	Patrick J. Weis, Jr.	203 Peele.....2407
Asst. Dir. for Women.....	Sarah E. Stone	203 Peele.....2905, 2407
Housing Rental Officer...	James S. Fulghum, Jr.	Leazar.....2440

I

Industrial and Technical Education		
Head.....	D. M. Hanson	111 Tompkins.....2241
Industrial Engineering		
Head.....	Clifton A. Anderson	328 Riddick.....2363
Industrial Extension		
Service.....	John R. Canada	241 Riddick.....2310
Field Service.....	John Hart	IES Bldg.....2357
Infirmary (See Health Service)		
Information Center (Union)...	Mrs. C.S. Philbrick	Main Desk, Union.....2455
Information Services		
Director.....	Hardy D. Berry	202 Holladay.....2874
Asst. Dir. (Publ.).....	Joseph S. Hancock	202 Holladay.....2874
Asst. Dir. (News).....	Graham Jones	202 Holladay.....2874

Name, Title, Department, and Address

Office Phone

International Programs.....Jack Rigney 12 Holladay.....2849

K

Knitting Technology
Head.....W. E. Shinn 110 Nelson.....2573

L

Landscape Architecture
Acting Head.....Lewis Clarke 213 Brooks.....2203,2205
Laundry and Dry Cleaning
Manager.....Joseph R. Gower Laundry.....2122
Liberal Arts, School of
Dean.....Fred V. Cahill 162 Harrelson.....2467
Library, D. H. Hill
Director.....I. T. Littleton 126 Library.....2595,2843
Assoc. Director.....Harlan C. Brown 301 Library.....2595,2843
Acquisitions.....Cyrus B. King 113 Library.....2841
Bibliographer.....Anne L. Turner 108 Library.....2598
Catalog.....M. Foy Lineberry 109 Library.....2598
Circulation.....Donald S. Keener 106 Library.....2845
Design Library.....Harrye B. Lyons 209 Brooks.....2207
Documents.....Mary E. Poole 118 Library.....2844
Photocopy.....Donna Daniel 27 Library.....2596
Reference.....Emma W. Pohl 122 Library.....2844
Reserve Room.....May R. Shuford 211 Library.....2597
Serials.....Gloria W. Houser 12 Library.....2842
Technical Information
Center.....William C. Lowe 234 Library.....2830
Textiles Library.....Divora Nielsen 112 Nelson.....2562
Tobacco Literature
Service.....Carmen Marin 205 Library.....2836

M

Machine Design (See Textile Machine Design)
Mathematics
Acting Head.....Hubert V. Park 252 Harrelson.....2382
Mathematics and Science Education
Head.....H. E. Speece 103 Tompkins.....2239
Mechanical and Aerospace Engineering
Head.....Robert W. Truitt 211 Broughton.....2365,2366
Microbiology
Head.....J. B. Evans 4515 Gardner.....2391
Mineral Industries
Head.....W. W. Austin 109 Page.....2379
Modern Languages
Head.....George W. Poland 303 Harrelson.....2475
Motor Pool.....Spencer Glascock 1 Morris.....2179
Music Activities
Director.....J. Perry Watson King Religious Cen.....2401

N

National Register Records Center
Manager.....George D. Clark Rm.100,505 Oberlin.....2866

Name, Title, Department, and Address

Office Phone

Naval Enlst. Science Education Program (NESEP)	
Admn. Officer.....Lt. James L. Wise, USN	342 Daniels.....2897
New Arts, Inc.....Lee McDonald	Union.....2451
News Services (See Information Services)	
Nuclear Engineering	
Head.....R. L. Murray	5 Burlington.....2302, 2303
Nuclear Operations	
Administrator.....J. R. Bohannon, Jr.	31 Burlington.....2322, 2323
Neutron Activation	
Analysis Lab.....W. B. Bowman, II	19 Burlington.....2322
Reactor & Lab Supvr.....J. L. Hite	22 Burlington.....2323
Nutritional Biochemistry....J. M. Leatherwood	318 Polk.....2773

O

Occupational Education, Center for	
Director.....John K. Coster	Primrose (Campus Mail)
	2100 Hillsborough..2493, 2494
Operations Research.....S. E. Elmaghraby	322 Riddick.....2350

P

Payroll Office.....Robert W. Dittmar	206 Holladay.....2151
Personnel Office	
Director.....James R. Swiger	Primrose.....2135, 2136
Asst. Director.....Robert T. Geile	Primrose.....2135, 2136
Staff Placement.....Nancy H. Webb	Primrose.....2135, 2136
Peru AID Program.....A. J. Coutu	1-G Patterson.....2671, 2672
Philosophy and Religion	
Head.....Robert S. Bryan	343 Harrelson.....2477
Physical Education	
Head.....Paul H. Derr	Carmichael.....2486
Physical Plant Division	
Director.....J. McCree Smith	101 Morris.....2181
Asst. Director.....Macon R. Rowland	102 Morris.....2181
Admn. Officer.....John E. Higgins	202 Morris.....2181
Supv. Contract Const.....Robert E. Fite	207-B Morris.....2181
Buildings Supt.....George F. Lynch	4 Park Shops.....2181
Coor. of Dept. Services..Stanford C. West	1 Park Shops.....2181
Utilities Supt.....Frank R. Kennedy	3 Park Shops.....2181
Supt. of Auto Services...Spencer B. Glascock	Morris.....2179
Grounds Supt.....Harold G. Bolick	1 Morris.....2181
Physical Sciences and Applied Mathematics, School of	
Dean.....A. C. Menius, Jr.	115 Gen. Lab Bldg..2501, 2502
Asst. Dean.....W. O. Doggett	116 Gen. Lab Bldg..2502, 2503
Physical Sciences Research	
Asst. Dean.....W. O. Doggett	116 Gen. Lab Bldg.....2503
Physics	
Head.....L. W. Seagondollar	106 Gen. Lab Bldg..2521, 2522
Phytotron	
Director.....R. J. Downs	1-A Patterson.....2823, 2824
Placement Center	
Director.....Raymond E. Tew	133 Daniels.....2396
Plant Pathology	
Head.....D. E. Ellis	2518 Gardner.....2735
Ext. Plant Pathology....H. R. Garriss	1410 Gardner.....2711
Police - Campus	Security Desk, Morris....2181
Politics	
Head.....William J. Block	102 Harrelson.....2482

Name, Title, Department, and Address

Office Phone

Poultry Science		
Head.....	H. W. Garren	120 Scott.....2626, 2627
Ext. Poultry Science.....	W. C. Mills	211 Scott.....2621
Print Shop		
Manager.....	L. B. Phillips	Dan Allen Dr.....2131, 2132
Asst. Manager.....	A. Wilton Kelly	Dan Allen Dr.....2131, 2132
Bindery.....	Harry L. Davis	Leazar.....2169
Product Design		
Head.....	Don A. Masterton	317 Brooks.....2205
Provost's Office		
Provost.....	Harry C. Kelly	109 Holladay.....2195
Asst. Provost.....	Nash N. Winstead	A Holladay.....2194
Asst. to the Provost.....	William H. Simpson	A Holladay.....2200
Psychology		
Head.....	Howard G. Miller	201 Tompkins.....2251
Publications (Student).....	Mrs. Catherine Mintz	King Religious Cen.....2412
Pulp and Paper Technology		
Head.....	R. G. Hitchings	106 Robertson Lab.....2889
Purchasing Agent.....	Felton D. Tilley	106 1911 Bldg.....2171
Asst. Purchasing Agent.....	Wilton L. Fleming	106 1911 Bldg.....2171

R

Radioisotopes and Reactor Safety Committee		
Chairman.....	C. Page Fisher	217 Mann.....2332
Radiological		
Safety Officer.....	L. T. Caruthers	214 Clark Lab.....2894, 2895
Radio Station WKNC-FM		
Manager.....	David Brown	King Religious Cen.....2400
Recreation Resources Administration		
Head.....	T. I. Hines	Field House.....2246, 2247
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Registrar.....	Ronald C. Butler	3 Peele.....2420
Asst. Registrar.....	C. P. Greyer	12-E Peele.....2434
Asst. Registrar.....	James H. Bundy	11 Peele.....2432
Asst. Registrar.....	Juanita Stott	14 Peele.....2445
Readmissions		14 Peele.....2438
Student Records and Permanent Files		7-A Peele.....2435
Transcripts		12-B Peele.....2436
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Chaplains to Students		
Baptist.....	L. P. Richardson	Baptist Stu. Union..834-1875
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Disciples of Christ....	Keith Roberson	718 Hillsborough...832-7112
Episcopal.....	Phillip C. Cato	King Religious Cen.....2414
Jewish.....	Rabbi H. A. Rabinowitz	King Religious Cen.....2414
Lutheran.....	John Cobb	2723 Clark Ave.....832-9687
Methodist.....	Neal McGlamery	2501 Clark Ave.....833-1861
Moravian.....	Edward T. Mickey	1752 Ridge Rd.....787-4034
Presbyterian.....	Jerrold Brooks	27 Horne St.....834-5184
Research		
Admn. Dean.....	H. F. Robinson	208 Daniels.....2117
Asst. Dean.....	N. W. Conner	208 Daniels.....2117
ROTC (See Air and Army)		

S

Social Studies		
Head.....	George A. Gullette	144 Harrelson.....2479
Sociology and Anthropology		
Head.....	Selz C. Mayo	360 Harrelson.....2491

Name, Title, Department, and Address

Office Phone

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Soil Science		
Head.....R. J. McCracken	222 Williams.....	2655
Ext. Soil Science.....G. L. Jones	252 Williams.....	2653
AID - Soil Testing.....J. W. Fitts	101 Williams.....	2630
Statistics (Experimental)		
Head.....D. D. Mason	110 Gen. Lab Bldg.....	2528
Student Accounts		
Supervisor.....W. R. Styons	B Holladay.....	2156
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Asst. Director.....Richard C. Snowdon	204 Peele.....	2442
Asst. Dir. for Women.....Carolyn S. Jessup	204 Peele.....	2442
Student Address Information (See Union)		
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Assoc. Dean.....Banks C. Talley, Jr.	202 Peele.....	2443
Student Government		
President.....Wes McClure	Union.....	2403
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Student Records	7-A Peele.....	2435
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Asst. Director.....Charles F. Kolb	133 1911 Bldg.....	2264

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Technician		
Editor.....Bob Harris	King Religious Cen.....	2411
Telephone Services		
Supervisor.....Olive B. Stone	116 Winston.....	2141
Operator.....Bessie B. Turner	116 Winston.....	0
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Director.....Jack Porter	27 ETV Studio.....	2854, 2855
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Textiles Library.....Davora Nielsen	112 Nelson.....	2562
Textile Machine Design		
Head.....C. M. Asbill, Jr.	B-22 Nelson.....	2565
Textile Research		
Director.....Robert W. Work	115 Clark Lab.....	2554
Textiles, School of		
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Academic Coordinator.....J. W. Klibbe	126 Nelson.....	2568
Asst.to Dean for Stu. Ser.		
& Asst. Placement Dir....W. E. Smith	120 Nelson.....	2572
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Morris S. Davis	Research Triangle	Ext. 55
	Park	

U

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Student Addresses and		
Telephone		
Theatre Director.....	Ira W. Allen	Main Desk, Union.....2455
University Extension		Frank Thompson Bldg.....2405
Admn. Dean.....	W. L. Turner	138 1911 Bldg.....2144
Asst. to the Dean.....	Grover Andrews	115 1911 Bldg.....2144
University Research Farms...	H. V. Marshall, Jr.	1-B Patterson.....2823, 2824

V

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Head.....	Landis S. Bennett	5 Ricks.....2861
Vocational Education Research		
Coordinating Unit.....	J. R. Clary	Primrose (Campus Mail)
		2100 Hillsborough St....2495

W

Water Resources Institute		
Director.....	David H. Howells	124 Riddick.....2815
Windhover		
Editor.....	Tom Antone	King Religious Cen.....2409
WKNC-FM Radio Station		
Manager.....	David Brown	King Religious Cen.....2400
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Wood Science and Technology		
Head.....	Eric L. Ellwood	160 Kilgore.....2884, 2883
WUNC-TV Television Station		
Director.....	Jack Porter	27 ETV Studio.....2854, 2855

Z

Zoology		
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Ext. Wildlife.....	H. M. Fields	Univ. Equip. Bldg.....2631

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Central Crops Research Station (NCSU).....	922-6468
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Coastal Plain Research Station (NCDA).....	285-2242
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Coastal Plain Vegetable Research Station (NCSU).....	267-3536
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Director.....W. W. Hassler	Hatteras
Horticultural Crops Research Station (NCSU).....	675-2314
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Mountain Horticultural Crops Research Station (NCSU).....	704-692-1630
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Mountain Research Station (NCDA).....	704-456-3943
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Supt.....Billy N. Ayscue	Box 1114, Oxford
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Director.....Donald B. Horton	Aurora
Peanut Belt Research Station (NCDA).....	397-2213
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Upper Mountain Research Station (NCDA).....	982-2501
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H. A. Stewart, 109 Patterson
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Biological Sciences Institute Dir.,
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127 An. Disease Lab
Animal Husbandry, E. R. Barrick,
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232 Polk
Ext. Dairy Husbandry, M. E. Senger,
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Dairy Records Center, V. H. Lytton,
Leazar
Nutritional Biochemistry,
J. M. Leatherwood, 318 Polk

Biochemistry, Gennard Matrone,
339 Polk
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ing, F. J. Hassler, 100 Bio. & Agri.
Engr. Bldg.
Ext. Biological and Agricultural
Engineering, H. M. Ellis,
200 Bio. & Agri. Engr. Bldg.
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258 Williams
Ext. Agronomy, G. L. Jones,
252 Williams
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216 Patterson
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220 Patterson
Ext. Marketing Economics,
George Capel, 210 Patterson
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2301 Gardner
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2309 Gardner
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Clothing, Mary Em Lee, 300 Ricks
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Housing-House Furnishings,
Charlotte Womble, 210 Ricks
Food Science, W. M. Roberts, 124 Polk
Ext. Food Science, W. M. Roberts,
124 Polk
Genetics, T. J. Mann, 3515 Gardner
Horticultural Science, C. W. Donoho, Jr.,
118 Kilgore
Ext. Horticulture, J. H. Harris,
235 Kilgore
Microbiology, J. B. Evans,
4515 Gardner
Plant Pathology, D. E. Ellis,
2518 Gardner
Ext. Plant Pathology,
H. R. Garriss, 1410 Gardner
Sociology and Anthropology,
S. C. Mayo, 360 Harrelson
Ext. Community Development,
J. W. Crawford, 240 1911 Bldg.
Soil Science, R. J. McCracken,
222 Williams
Ext. Soil Science, G. L. Jones,
252 Williams
AID-Soil Testing, J. W. Fitts,
101 Williams
Zoology, David E. Davis,
2124 Gardner
Ext. Wildlife, H. M. Fields,
Univ. Equip. Bldg.

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303 Brooks

Landscape Architecture, Lewis Clarke,
Acting Head, 213 Brooks

Product Design, Don A. Masterton,
317 Brooks

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Agricultural Education, C.C. Scarborough,
123 Tompkins

Guidance and Personnel Services,
W. E. Hopke, 209 Tompkins

Industrial and Technical Education,
D. M. Hanson, 111 Tompkins

Mathematics and Science Education,
H. E. Speece, 103 Tompkins

Psychology, H. G. Miller, 201 Tompkins

ENGINEERING

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Assoc. Dean, R. G. Carson, 232 Riddick
Assoc. Dean, H. B. Smith, 224 Riddick
Engr. Stu. Affairs, W. E. Adams,
232 Riddick

Industrial Extension Service,
John R. Canada, 241 Riddick

Departments

Freshman Engineering Division,
239 Riddick

Biological and Agricultural Engineering,
F. J. Hassler, 100 Bio. & Agri. Engr.
Bldg.

Chemical Engineering, J. K. Ferrell,
113 Riddick

Civil Engineering, D. L. Dean, 208 Mann
Electrical Engineering, G. B. Hoadley,
240 Daniels

Engineering Mechanics, P. H. McDonald,
119 Riddick

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331 Riddick

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129 Riddick

Industrial Engineering, Clifton A.
Anderson, 328 Riddick

Mechanical and Aerospace Engineering,
R. W. Truitt, 211 Broughton

Mineral Industries, W. W. Austin, 109 Page
Nuclear Engineering, R. L. Murray,
5 Burlington

Nuclear Operations, J. R. Bohannon Jr.,
31 Burlington

FOREST RESOURCES

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Asst. to the Dean, L. C. Saylor,
162 Kilgore

Departments

Forestry, T. E. Maki,
272 Kilgore

Forestry Extension, Walter M. Keller,
264 Kilgore

Pulp and Paper Technology,
R. G. Hitchings, 106 Robertson Lab

Recreation Resources Administration,
T. I. Hines, Field House

Wood Science and Technology,
E.L. Ellwood, 160 Kilgore
Wood Products Lab, R. C. Gilmore,
Hodges Lab

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121 Harrelson

English, Lodwick Hartley, 120 Winston
History, R. W. Greenlaw, 110 Harrelson

Modern Languages, G. W. Poland,
303 Harrelson

Philosophy and Religion, R.S. Bryan,
343 Harrelson

Physical Education, P. H. Derr,
Carmichael

Politics, W. J. Block, 102 Harrelson
Social Studies, G. A. Gullette,
144 Harrelson

Sociology and Anthropology,
S. C. Mayo, 360 Harrelson

PHYSICAL SCIENCES AND APPLIED MATHEMATICS

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115 General Lab Bldg.
Asst. Dean, W. O. Doggett,
116 General Lab Bldg.

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108 Withers

Computer Science, P. E. Lewis,
Acting Head, B-1 Nelson

Computing Center, Kevin R. Jones,
Acting Dir., 8-B Nelson

Experimental Statistics, D. D. Mason,
110 General Lab Bldg.

Geosciences, C. J. Leith, Acting Head,
210 Page

Mathematics, Hubert V. Park,
Acting Head, 252 Harrelson

Physical Sciences Research,
W. O. Doggett, 116 Gen. Lab Bldg.

Physics, L. W. Seagondollar,
106 General Lab Bldg.

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126 Nelson
Asst. to the Dean for Student Services
and Asst. Placement Dir., W. E. Smith,
120 Nelson
Textiles Library, Davora Nielson,
112 Nelson
Textile Research, R. W. Work
115 David Clark Lab

Departments

Knitting Technology, W. E. Shinn,
110 Nelson
Textile Chemistry, H. A. Rutherford,
115 David Clark Lab
Textile Machine Design, C. M. Asbill,
B-22 Nelson
Textile Technology, D. S. Hamby,
102 Nelson

GRADUATE SCHOOL

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Asst. Dean, Vernon E. Holt, 104 Peele

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Alumni Bldg.

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106 Coliseum
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115 Coliseum
Golf, Albert P. Michaels,
115 Coliseum
Rifle, Sgt. Allen Vestal,
154 Coliseum
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122 Coliseum
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9 Holladay
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108 Morris
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Slater Food Services Dir.,
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Operator, Bessie B. Turner,
116 Winston
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105 Holladay
Asst. Dir., R. E. Gresham,
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Staff Placement Officer,
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102 Morris
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4 Park Shops
Contract Construction Supv.,
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Departmental Services Coordinator,
Sanford C. West, 1 Park Shops

Grounds Supt., Harold G. Bolick,
 1 Morris
 Utilities Supt., Frank R. Kennedy,
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 106 1911 Bldg.
 Asst.Agent, Wilton L. Fleming,
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 Student Accounts Supv., W. R. Styons,
 B Holladay
 Student Loan Officer, Helen Dickens,
 B Holladay
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 Asst.Mgr., T.V. Setzer, SSS Bldg.
 Building Mgr., G. Graham Glass, SSS Bldg.
 Engr. Supplies Dept Mgr., Willard
 Carpenter, SSS Bldg.
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 Traffic Records Officer, Mrs. Ester Hinton,
 136 Coliseum

COLISEUM, WILLIAM NEAL REYNOLDS

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 101 Coliseum
 Concessions Mgr., Wiley L. Gouge, Jr.,
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 133 1911 Bldg.
 Asst.Dir., James I. Mason,
 136 1911 Bldg.
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 123 1911 Bldg.
 Coordinator, Kelly R. Crump,
 124 1911 Bldg.
 Coordinator, Maynard E. Shields,
 120 1911 Bldg.

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 193 Williams

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Manager, R. W. McMillen, 124 Williams

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 12 Holladay
 Asst.Dir., C. W. Hart,
 12 Holladay
 Asst.Dir., R. N. Wood,
 12 Holladay

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 202 Holladay
 Asst.Dir., (Publications), Joseph
 S. Hancock, 202 Holladay
 Asst.Dir., (News), Graham E. Jones,
 202 Holladay

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 126 Library
 Assoc.Dir., Harlan C. Brown,
 301 Library
 Acquisitions, Cyrus B. King,
 113 Library
 Bibliographer, Anne L. Turner,
 108 Library
 Catalog, M. Foy Lineberry,
 109 Library
 Circulation, Donald S. Keener,
 106 Library
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 209 Brooks
 Documents, Mary E. Poole,
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 Photocopy, Donna Daniel,
 27 Library
 Reference, Emma W. Pohl,
 122 Library
 Reserve Room, May R. Shuford,
 211 Library
 Serials, Gloria W. Houser,
 12 Library
 Technical Information Center,
 William C. Lowe, 234 Library
 Textiles Library, Davora Nielsen,
 112 Nelson
 Tobacco Literature Service,
 Carmen Marin, 205 Library
 NATIONAL REGISTER RECORDS CENTER
 Manager, George D. Clark, Rm. 100,
 505 Oberlin Rd.

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 Vice Chairman, W. O. Doggett,
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 Radiation Safety
 Radiological Safety Officer,
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 Asst.Officer, D. W. Morgan,
 214 Clark Lab

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Assoc. Dean, Banks C. Talley, Jr.

202 Peele

Student Activities

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2419 Gardner; 705 Nellane Dr., Garner		
*Bennett, Nancy E., Typist II, Zoology.....	322-5542	322-4262
Pamlico Marine Lab, Box 305, Rt. 2, Aurora; Box 505, Blunts Creek		
*Bennett, Roy R., Prof. Emeritus, Crop Science.....		832-1210
2922 Barmettler St.		
*Bennett, Thomasene, Secretary, Peru Contract.....	2671	787-1348
1 Patterson		
*Bennett, Dr. Willard H., Prof., Physics.....	2505	787-2173
200 Daniels; 5500 North Hills Dr.		
Bennington, Sheila R., Steno II, Mathematics.....	2382	832-0704
255 Harrelson; 225 East Lane St.		
*Bentley, Elizabeth T., Admin. Secretary, Plant Pathology....	2735	834-5821
2518 Gardner; 5304 Barclay Dr.		
*Bentley, John W., Agri. Research Suprv., Crop Science.....	2657	832-6247
186 Williams; Rt. 4, Box 675, Raleigh		
Bernat, Sophia, Stat. Clerk, Economics.....	2826	828-3244
7 Patterson; 1835 Smallwood Dr.		
*Berry, Ernest B., Assoc. Prof., Textile Technology.....	2568	834-4492
206 Nelson; Rt. 1, Box 155, Raleigh		
*Berry, Hardy D., Director, Information Services.....	2874	787-6587
202 Holladay; 2601 Wells Ave.		
Betts, Dr. Leonidas J., Asst. Prof., English.....	2461	833-7678
7-9 Winston; 2507 Beech Ridge Rd.		

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Name, Title, Department, and Address	Office Phone	Res. Phone
*Beville, George E., Budget & Accounting.....	2148	787-3073
103 Holladay; 301 Latimer Rd.		
*Bhattacharyya, Dr. Bibhuti B., Assoc.Prof., Exp. Stat.....	2534	834-3547
604 General Lab Bldg.; 1340 Chester Rd.		
*Bickford, Carlos P., Inst., Int. Soil Test, Soil Science.....	2277	
101 Williams; US/Aid, Costa Rica, c/o Amer. Embassy, San Jose, Costa Rica		
*Billingsley, E. Page, Admin. Sec., Physical Plant.....	2181	787-7932
100 Morris; 1611 Brooks Ave.		
*Bingham, Dr. Robert J., Asst. Prof., Food Science.....	2776	787-1893
128-D Polk; 5019 Tanglewood Dr.		
*Bingham, Dr. William L., Assoc. Prof., Engineering Mechanics.....	2343	833-9634
347 Riddick; 5207 Dillard Dr.		
*Bird, Marion W., Visiting Prof., Education.....	832-4825	787-9216
1517 Oakwood Ave.; 4016 Converse Dr.		
*Bireline, G. L., Assoc. Prof., Design.....	2206	833-8033
101 Brooks; 228 East Park Dr.		
*Bireline, Mrs. J. M., Instructor, Physics.....	2513	833-8033
410-A Gen. Lab Bldg.; 228 East Park Dr.		
*Bishir, Dr. John W., Assoc. Prof., Mathematics.....	2384	782-0687
230 Harrelson; 2019 Dixie Tr.		
*Bishop, Dessie C., Sectetary, Religious Affairs, Div. of.....	2414	832-0672
Student Affairs: King Religious Center; 8 Bagwell Ave.		
Black, Clarence S., Supt., Sandhills Research Station	974-4201	
Jackson Springs		
*Black, Margaret E., Steno II, Facilities Planning Div.....	2121	828-3734
Watauga, West Entrance; 616 Drew St.		
Blackmon, Maxine, Typist II, Registration & Records.....	2420	787-1204
3 Peele; 3504 Horton St., Apt. 304		
Blackmon, Theron D., Dairy Plant Operator, Food Science.....	2700	934-4793
Polk; Rt. 1, Clayton		
Blackwelder, James R., Instructor, English.....	2463	833-2056
218-20 Winston; E-1 Basement, Grosvenor Gardens		
Blackwell, Harley E., Supt., Mtn.Hort.Crops Res.Sta.....	692-1630	693-9501
Rt. 2, Fletcher		
*Blackwood, Clara S., Agri. Research Tech., Soil Science.....	2389	833-2283
383 Williams; 1070 Nichols Dr.		
*Blackwood, Worth T., Chief Security Officer, Physical Plant..	2181	266-2054
Morris; Rt. 5, Raleigh		
*Blake, Dr. Carl T., Ext. Assoc. Prof., Crop Science.....	2639	787-6554
152 Williams; 4509 Leaf Ct.		
*Blake, William O., Agri. Research Asst., Univ. Research.....	2713	828-4298
Farms; 3614 Western Blvd.; Rt. 8, Raleigh		
*Blalock, Doretha J., Library Asst., Acqs. Dept.,.....	2841	828-5964
112 D. H. Hill Library; 2215 Garner Rd.		
*Blalock, Dr. T. Carlton, Asst. Dir., Agri. Ext.,....	2801, 2802, 2803	787-5909
4-H Clubs; 201 Ricks; 1315 Brooks Ave.		
*Blalock, Thomas J., Asst. Prof., Chemistry.....	2549	787-6157
103 Withers; 3504 Churchill Rd.		
*Blank, Dr. Philip E., Jr., Asst. Prof., English.....	2464	832-2469
115 Winston; 3002 Warren Ave.		
Blaylock, Miss M. Loyce, Steno, Education	2232, 2231	832-7038
118 Tompkins; 1509 Caswell St.		
*Bliss, Milton C., Asst. Dir., Music, Div. of Student.....	2401	833-8994
Affairs: 205 King Religious Center; 101 Dixie Tr.		
*Block, Dr. William J., Prof. & Head, Politics.....	2482-2481	834-8353
103 Harrelson; 5227 Melbourne Rd.		
*Blow, Dr. William L., Assoc. Prof., Poultry Science.....	2623	833-6806
205 Scott; 304 Furches St.		
*Blue, Henry D., Maint.Supvr., Union, Div.of Stu.Affairs.....	2454	556-3771
Erdahl-Cloyd Union; 436 Waite Ave., Wake Forest		
*Blum, George B., Jr., Assoc.Prof., Biological & Agri.....	2697, 2696	834-1578
Engr.: 111 Bio. & Agri. Engr. Bldg.; 1408 Trailwood Dr.		
*Blumer, Dr. Thomas N., Prof., Food Science.....	2778	834-3593
203 Polk; 350 Meredith St.		
*Boal, Robert S., Ext. Assoc. Prof., Economics.....	2258	556-4323
18 Patterson; 121 W. Sycamore Ave., Wake Forest		

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Name, Title, Department, and Address	Office Phone	Res. Phone
*Boan, Kay S., Agri. Research Tech., Food Science.....	2795	755-2914
137 Polk; 15538 Lee, NCSU.		
*Boaz, Joseph N., Prof., Architecture.....	2204	787-7866
308 Brooks; 2305 Myron Dr., Apt. E.		
*Boettner, George R., Instructor, Phys. Education.....	2487	834-8100
445 Carmichael; 824 Graham St.		
*Bogdan, John F., Prof., Textile Tech.,.....	2569	787-4402
107 Nelson; 2120 Ridge Rd.		
*Bogey, Thomas W., Receiving & Inventory Mgr., Book Dept.....	2161	832-0689
Student Supply Stores; 1300 Londonderry Cir.		
*Bohannon, James R., Jr., Assoc. Prof. & Nuclear Oper....	2322, 2323	787-7493
Admin.: 31 Burlington Lab; 5613 Deblyn Ave.		
*Boland, Cathryn, Accounting Clerk, Continuing Education.....	2261	787-1617
119 1911 Bldg; 5014 Tanglewood Dr.		
*Bolick, Harold G., Grounds Supt., Physical Plant.....	2181	828-5791
W. Riddick; 5007 Western Blvd.		
Booker, Leslie Jane, Data Processor, Dairy Rec. Proc. Cen....	2632	833-4366
Animal Science; West End, Basement, Leazar; 624 Gannett St.		
Boone, Dan H., Research Engineer, Bio. & Agri. Engr.....	2662	942-3008
134 Bio. & Agri. Engr. Bldg.; Rt. 1, Box 17-A, Chapel Hill		
*Boone, Dr. Edgar J., Prof. & Head, Adult Edu., Asst. Dir.,....	2707	787-3486
Agri. Ext.: 117 Ricks; 4918 Rembert Dr.		
*Boone, Ruth S., Secretary, Philosophy & Religion.....	2477	834-2584
344 Harrelson; 608 Beaver Dam Rd.		
*Borenski, Dr. R. J., Visiting Inst., Economics.....	2603	832-4117
16 Patterson; 4 Maiden Ln.		
*Borth, Betty W., Nurse, Health Services, Div. of Student....	2410	832-5117
Affairs; Clark Infirmary; 3101 Devonshire Rd.		
*Bostian, Dr. Carey H., Prof., Genetics.....	2291	787-5434
3518 Gardner; 1002 Lake Boone Tr.		
Boswell, Beverly A., Clerk, Print Shop.....	2131	833-6838
Dan Allen Dr.; 2030 Carroll Dr.		
*Bowen, Dr. Henry D., Prof., Bio. & Agri. Engr.....	2662	787-8349
157 Bio. & Agri. Engr. Bldg.; 2200 Charlotte Ct.		
Bowen, Dr. Lawrence H., Assoc Prof., Chemistry.....	2538	787-9869
311 Withers; 4315 Leesville Rd., 30-D.		
*Bowers, Henry, Dir., Erdahl-Cloyd Union, Div. of Student....	2452	787-6408
Affairs; Union; 3426 Bradley Pl.		
Bowman, Worth B., II, Reactor Engineer, Nuclear Engr.....	2322	787-1296
19 Burlington Lab; 5320 Coronado Dr.		
*Boynton, Dr. Damon, Visiting Prof., Hort. Peru Con.....	2671	
1 Patterson; Peru		
Bradbury, Dr. Phyllis C., Asst. Prof., Zoology.....	2592, 2741	832-1373
1638 Gardner; 2376 Champion Ct.		
*Bradford, Edward H., Assoc. Prof., Textile Tech.....	2560	787-1600
303 Nelson; 4120 Galax Dr.		
*Bradford, Garnett L., Asst. Prof., Economics.....	2607	787-0458
4-B Patterson; 721 Shelley Rd.		
*Bradford, Ithel E., Stock Clerk II, Central Stores.....	2198, 2197	828-9819
108 Morris; 417 Harding St.		
*Bradley, Dr. J. R., Asst. Prof., Entomology.....	2745	832-4908
4301 Gardner; 5417 Pennwood Dr.		
*Bradley, Roderick W., Attendance Officer, Student Activities,	2442	467-1436
Div. of Stu. Affairs; 204 Peele; Rt. 1, Box 638-14, Cary		
*Brady, Mary E., Library Asst., Acqs. Dept., Library.....	2841	834-4635
112 D. H. Hill Library; 1608 Benehan St.		
Brady, Robert A., Computer Programmer, Computing Center.....	2518	833-9424
11-E Nelson; 531 N. Blount St., Apt. 301		
Bramer, Charles R., Prof., Civil Engineering.....	2334	787-9078
200 Mann; 2729 Oberlin Rd.		
Branch, Connie, Asst. Manager, ARA Slater.....	2857	832-9816
Harris; 2609 Clark Ave.		
*Branch, Samuel D., Electronics Tech., Bio. & Agri. Engr.....	2682	467-1598
117 Bio. & Agri. Engr. Bldg.; 511 Morningside Dr., Cary		

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Name, Title, Department, and Address	Office Phone	Res. Phone
*Brandt, Dr. Bartholamew B., Prof. Emeritus, Zoology.....	2741	833-7009
2124 Gardner; 3218 Bedford Ave.		
*Brant, Dorothy L., Instructor, Mathematics.....	2386	832-7791
333 Harrelson; 2404 Beechridge Rd.		
*Brantley, Leroy, Farm Hand, Univ. Research Farm.....	2713	
3614 Western Blvd.; Rt. 2, Zebulon		
*Brantley, Peggy Y., Typist III, Crop Science.....	2648	467-1349
256 Williams; Box 414, Cary		
*Brantley, Vester R., Asst. Prof., Mathematics.....	2386	833-0022
336 Harrelson; 152 Jones-Franklin Rd.		
*Brantly, Eugene P., Asst. Prof., Civil Engineering	2333	834-7693
316 Mann; 2230 The Circle		
Brasfield, M. Helen, Research Asst., Biochemistry.....	2584	828-3267
4608 Gardner; 807-D Daniels St.		
*Bredenberg, Dr. Paul A., Prof., Philosophy & Religion.....	2477	834-5352
347 Harrelson; 1600 Crump Rd.		
*Breisford, Charlene K., Ext. Food Specialist, Foods &	2787	787-6924
Nutrition, Agri. Ext.: 213-A Ricks; 3709 Deerwood Dr.		
*Bretton, Frank, Asst. Dir., Dining Service, ARA Slater.....	2878	834-0860
Leazar; 306 Acron St.		
*Brett, Dr. Charles H., Prof., Entomology.....	2745	787-6056
3309 Gardner; 1425 Dixie Trail		
*Brewbaker, Carey L., Asst. Football Coach, Athletics....	2104, 2103	834-4131
115 Coliseum; 2512 Clark Ave.		
*Bridge, Gladys G., Clerk, Registration & Records	2435	556-3525
7 Peele; Box 1048, Wake Forest		
Bridgers, Eleanor F., Steno, Mechanical & Aerospace Engr....	2366	828-8506
211 Broughton; F4, Crabtree Manor, Six Forks Rd.		
+Bridges, William S., Assoc Prof. Emeritus, Mechanical &.....		832-4159
Aerospace Engineering; 125½ Chamberlain St.		
*Brieaddy, Virginia G., Typist, Acqs. Dept., Library.....	2841	833-4171
112 D. H. Hill Library; 2304 McMullan Cir.		
*Brierley, Eileen B., Clerk II, Student Accts., Business.....	2143	772-3365
Affairs; B Holladay; 1307 Sycamore Dr., Garner		
*Briggs, Hermon B., Prof. Emeritus, Mechanical & Aerospace....		
Engineering; Black Mountain		
Briggs, Mary M, Steno II, Crop Science.....	2657	832-7156
156 Williams; G-1 Raleigh Apts.		
*Bright, H. Ray, Studio Engineer, WUNC-TV.....	2853	828-8680
1317 Western Blvd.; 4811 Montacute St.		
*Bright, Richard, Professor, Chemical Engineering.....	2329	833-3331
107 Riddick; Rt. 7, Raleigh		
*Brim, Dr. Charles A., Professor, Crop Science.....	2704, 2705	787-4233
112 Williams; 1713 Nottingham Rd.		
*Brisson, Robert C., Instructor, Sociology & Anthro.....	2491	834-1238
361 Harrelson; 3336 Briarcliff Rd.		
*Britt, Southgate T., Research Supvr., Soil Science.....	2389	834-1949
362 Williams; 808 Colleton Rd.		
*Brockman, Grace W., Agri. Research Supvr., Poultry Science...	2623	834-1800
225 Scott; 2612 Clark Ave.		
*Brogden, Louise N., Bindery, Print Shop.....	2169	832-8418
Leazar; 1212 Thomas St.		
*Broman, Carol A., Agri. Research Asst., Plant Pathology.....	2752	833-6738
3402 Gardner; 1104 W. Lenoir St.		
*Bronson, James D., Farm Worker, Univ. Research Farms.....	2713	
3614 Western Blvd.; Rock Quarry Rd.		
*Brooks, Dwaine R., Agri. Research Asst. I, Animal Science....	2759	
Fincrest Farm; Rt. 3, Raleigh		
*Brooks, Rev. Jerrold L., Pres. Chaplain, Rel. Aff., Div. of Stu. .	834-5184	833-5228
Aff.: 27 Horne St.; 2815 Barmettler St.		
*Brooks, Joseph F., Ext. Asst. Prof., Horticultural Science...	2686	467-1184
227 Kilgore; 426 Pleasants Ave., Cary		
*Brooks, Louise C., Typist, Traffic Records.....	2120	772-3031
136 Coliseum		

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Name, Title, Department, and Address	Office Phone	Res. Phone
*Brooks, Dr. R. Charles, Ext. Assoc. Prof., Economics.....	2256	467-9455
209 Patterson; 1216 Kingston Ridge Dr., Cary		
*Brooks, Dr. Wayne M., Asst. Prof., Entomology.....	2620	787-8306
2315 Gardner; 4716 Latimer Rd.		
*Brose, King R., Research Assoc., Engineering Research.....	2349	834-0701
143-D Riddick; 370 Wilmot Dr.		
*Broughton, Forest H., Jr., Printer, Print Shop.....	2132	834-8533
Dan Allen Dr.; 4105 Jane Ln.		
Brown, Betty, Steno II, Ext. Agronomy, Crop Science.....	2639	787-8239
128 Williams; Palms Ct., Apt. 304		
*Brown, Edmond J., Asst. Prof., Physics.....	2151	833-1168
406-E Gen. Lab; 1321 Jones-Franklin Rd.		
+Brown, Gail, Steno II, Office of Provost.....	2193, 2200	787-7297
A Holladay; 209 Ramblewood Dr., Tara Apt. 97		
*Brown, Harlan C., Assoc. Dir., D. H. Hill Library.....	2843, 2595	833-4484
301 Library; 3217 Merriman Ave.		
*Brown, Dr. Henry S., Prof., Geosciences.....	2378	787-5020
207 Page; 3439 Redbud Ln.		
+Brown, Jean C., Tech., Genetics.....	2294	834-9023
3615 Gardner; 2715-A Kilgore Ave.		
*Brown, Jesse C., Maint. Mech., Food Science.....	2691, 2692	922-6621
21 Kilgore; 504 S. John St., Clayton		
*Brown, Joseph, Agri. Research Asst., Poultry Science.....	2628	
Scott; K-12 Washington Ter.		
*Brown, Kenneth A., Draftsman, Ext. Bio. & Agri. Engr.....	2675	772-4663
212 Bio. & Agri. Engr. Bldg.; 1001 Park Ave., Garner		
Brown, Mrs. Lois S., Dist. Home Ec. Agent, Agricultural Ext.....	2708	833-7896
300 Ricks; E-43 Washington Ter.		
*Brown, Luther E., Research Supvr., Soil Science.....	2389	833-6072
382 Williams; 432 Rose Ln.		
Brown, M. Howard, Clerk, Purchasing.....	2171	
100 1911 Bldg.; 209 YMCA, 1601 Hillsborough St.		
*Brown, Dr. Marvin L., Prof., History.....	2484	772-2373
115 Harrelson; Rt. 3, Box 593, Raleigh		
*Brown, Minnie M., State Home Ec. Agent, Agri. Ext.....	2770	
218 Ricks; Carolina Hotel, Apt. 3		
*Brown, Ruby E., Nurse, Health Services, Div. of Student.....	2410	833-9988
Affairs; Clark Infirmary; 6214 Arrington Rd.		
*Brown, Talmage T., Assoc. Prof., Poultry Science.....	2627	832-9731
126 Scott; 1709 Bickett Blvd.		
*Brown, Dr. William J. Jr., Asst. Dir., Research Coord. Unit.....	2495	787-6660
Mail: Primrose, Office: 2100 Hillsborough St.; 1909 Hillock Dr.		
*Brown, Dr. Wyn, Assoc. Prof., Wood Chemistry, Forest.....	2889	834-8830
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Browne, Cicely C., Agri. Research Tech., Forest Genetics.....	2880	787-5326
254 Kilgore; 3212 Wade Ave.		
Browne, P. Diane, Steno II, Nuclear Engineering.....	2303	832-0682
4 Burlington Lab; St. Mary's St.		
*Broyles, Ned B., Coordinator, Continuing Education.....	2261	787-6711
123 1911 Bldg.; 2132 Buckingham Rd.		
*Bryan, Dwight M., Research Asst. III, Soil Science.....	2657	772-4989
188 Williams; Rt. 1, Garner		
*Bryan, James E., Visiting Asst. Prof., Horticultural....	2671, 2672	
Sci., Peru Contract: 1 Patterson; Peru		
*Bryan, Loddie D., Lecturer, Land Arch.,	2202	787-8706
200 Brooks; 1920 Myron Dr.		
*Bryan, Dr. Robert S., Prof. & Head, Philosophy & Religion....	2477	787-8494
343 Harrelson; 2301 Tyson St.		
*Bryan, Sadie W., Statistical Analyst, Poultry Science.....	2623	772-4989
202 Scott; Rt. 1, Garner		
*Bryant, Dr. C. Douglas, Asst. Prof., Agricultural Education..	2234	467-1759
123 Tompkins; 921 Warren Ave., Cary		
*Bryant, K. M. (Charlie), Asst. Basketball Coach.....	2105	787-2016
Athletics: 106 Coliseum; 401 N. Glenn Dr.		

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Name, Title, Department, and Address	Office Phone	Res. Phone
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150 Kilgore; 4516 Aventura Ferry Rd.		
*Buchanan, J. S., Ext. Prof., Animal Science.....	2762	787-5187
111 Polk; 2622 Grant Ave.		
*Buchdahl, Dr. Rolf, Adjunct Prof., Mech. & Aerospace Engr.....		787-4834
119 Broughton; 3905 Blue Ridge Rd.		
*Buck, Martha G., Steno, Counseling, Div. of Stu. Affairs....	2421	834-2965
205 Peele; 1508 Stovall Dr., No. 35		
Buckley, K. Isabelle, Specialist in Aging, Agri. Ext.....	2770	833-5155
218 Ricks; 3404 Cherry Ln.		
*Buffaloe, Dr. William J., Adj. Assoc. Prof., Soc. & Anth....	2491	834-4111
Dorothea Dix Hospital; 2028 Fairview Rd.		
*Bullock, Dr. Roberts C., Prof., Mathematics.....	2384	787-6797
241-A Harrelson; 1415 Dixie Tr.		
*Bumgardner, Dr. Carl L., Prof., Chemistry.....	2549	787-3603
103 Withers; 4113 Glen Laurel Dr.		
Bumgardner, Dr. Harvey L., Ext. Assoc. Prof., Poultry Sci....	2671	
Chief, N.C. Mission to Peru; 1 Patterson; Peru		
*Bunch, Luther V., Jr., Research Suprv., Crop Science.....	2657	787-0767
182 Williams; Rt. 8, Raleigh		
*Bundy, James H., Asst. Registrar, Student Affairs.....	2432	832-6625
11 Peele; 424 Wayne Dr.		
*Bunn, Aubrey N., Dairy Plant Oper., Food Science.....	2700	
Polk; 520 2nd St., Clayton		
*Bunn, M. M., Print Shop.....	2132	828-5679
Dan Allen Dr.; 3610 Melrose Dr.		
Bunn, William G., Agri. Research Asst., Animal Science.....		
4700 Hillsborough St.; Rt. 4, Box 41-H, Raleigh		
*Bunzey, Ronald R., Instrument Maker II, Nuclear Engineering..	2508	467-1677
7 Gen. Lab; 935 Hillview		
*Buol, Dr. Stanley W., Assoc. Prof., Soil Science.....	2636	772-0541
330 Williams; 1401 Lakeside Dr., Garner		
*Burchette, Margaret, Steno II, Forest Resources.....	2883	832-4116
164 Kilgore; 119 Peartree Ln.		
*Burfening, Susan S., Research Asst. III, Genetics.....	2289	828-9736
2631 Gardner; 202 Jones Franklin Rd.		
*Burgess, Nora E. (Rita), Steno, Adult Education.....	2707	833-6933
117 Ricks; 1322 Pineview Dr.		
*Burnette, Battle L., Warehouse Mgr., Chemistry.....	2539	772-4183
26 Withers; Rt. 3, Raleigh		
*Burnette, William H., Maint. Mech., Industrial Engineering...	2361	354-6672
110 Park Shop; Rt. 3, Apex		
*Burniston, Dr. Ernest E., Assoc. Prof., Mathematics.....	2384	787-8570
236 Harrelson; 4301 Union St.		
*Burns, Dr. Joseph C., Asst. Prof., Crop Science.....	2657	832-2779
186 Williams; 813 Ravenwood Dr.		
Burns, Joyce A., Research Suprv., Crop Science.....	2644	787-2563
486 Williams; Rt. 8, Lake Boone Tr.		
*Burns, Robert P., Head & Assoc. Prof., Architecture.....	2204, 2206	834-0846
303 Brooks; 2706 Rosedale Ave.		
*Burrill, Roy P., Agri. Research Asst., Plant Pathology.....	2722	
2518 Gardner; 3522 Sherry Dr.		
Burroughs, Nancy J., Steno, Engineering Mechanics.....	2341, 2342	834-4756
119 Riddick; 323 Sunnybrook Rd.		
*Burt, Excell, Nursery Worker, Horticultural Science.....	2823	
Hort. Science Farm, Method; Rt. 1, Apex		
*Burton, Eva S., Agri. Research Asst., Poultry Science.....	2729	832-4911
Poultry Farm; 716 South McDowell St.		
*Burwell, Bessye M., Steno II, Center for Occupational Ed....	2701	834-3011
329 1911 Bldg.; 909 Seabrook Rd.		
*Busbice, Dr. Thad H., Asst. Prof., Crop Science.....	2658	833-6621
182 Williams; 205-B Dixie Tr.		
*Busta, Dr. Francis F., Assoc. Prof., Food Science.....	2795	787-4566
128 Polk; 4501 Boxwood Rd.		

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Butler, E. Maxine, Accounting Clerk, Crop Science.....	2648	828-8602
254 Williams; M-5, 2300 Avent Ferry Rd.		
*Butler, Lillian S., Agri. Research Tech., Food Science..	2691,2692	787-5503
3 Kilgore; 3332 Ocotea St.		
*Butler, Ronald C., Registrar, Registration & Records.....	2420	832-1800
14 Peele; 544 Cooper Rd.		
Byer, James E., Instructor, English.....	2463	834-4017
221-23 Winston; 5-A Grosvenor Gardens		
*Byrd, Barbara M., Programming Supvr., NRRC.....	2866	828-6483
505 Oberlin Rd., Rm. 100; Rt. 4, Box 712, Raleigh		
*Byrd, Barbara P., Typist II, Central Stores.....	2198,2197	772-0598
108 Morris; 414 Avery St., Garner		
*Byrd, Billy R., Agri. Research Asst., Food Science.....	2795	365-5632
136 Polk; Box 658, Wendell		
*Byrd, Dewitt, Jr., Agri. Research Tech., Plant Pathology....	2735	365-7231
2618 Gardner; Rt. 1, Wendell		
*Byrd, JoAnn, Steno, Economics.....	2472	365-5632
133 Harrelson; Box 658, Wendell		
*Byrd, Peggy N., Secretary, Continuing Education.....	2261	922-6524
121 1911 Bldg; Rt. 1, Box 573, Clayton		
*Byrd, Thomas M., News Editor, Agricultural Information.....	2800	467-9848
118 Ricks; 903 Washington St., Cary		

C

*Cabe, Joann B., Secretary, Bio. & Agri. Engr.....	2662	782-0652
137 Bio. & Agri. Engr. Bldg.; 3600 Horton St., Apt. 103		
*Cahall, Robert M., Asst. Bldgs. Supt., Shops, Physical Plant..	2181	832-6678
3 Park Shops; 2335 Lyon St.		
*Cahill, Dr. Fred V., Dean, Liberal Arts.....	2467,2468	787-2838
162 Harrelson; 4801 Yadkin Dr.		
*Cahoon, Linda R., Clerk, Physical Plant.....	2181	834-1205
204 Morris; 2731 Poole Rd.		
*Caldwell, Ann C., Clerk, Agri. & Life Sciences.....	2715	787-8341
120-H Patterson; 820 Lake Boone Tr.		
*Caldwell, Dr. John Tyler, Chancellor.....	2191	828-6642
A Holladay; 1903 Hillsborough St.		
*Callis, John M., Research Asst., Crop Science.....	2650	552-5829
428 Williams; Rt. 1, Box 2, Raleigh		
+Camp, Allene M., Nurse, Health Service, Div. of Stu.Affairs..	2410	833-6078
Clark Infirmary; 3210½ Clark Ave.		
*Camp, Mary M., Steno II, Graduate Office.....	2872	467-8324
104 Peele; 511 Ridgecrest Rd., Cary		
*Campbell, D. Graham, D. P. Manager, Business Affairs.....	2140	787-5113
2 Holladay; 4605 Drexel Dr.		
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241 Riddick; 209 Merwin Rd.		
*Canady, Judith C., Library Asst., Inter-library Center.....	2845	787-3605
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+Cannon, Isabella W., Secretary, Dir.Office, Library.....	2843,2595	834-6017
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*Cobb, Danielle S., Library Asst., Reserve Room, Library..... 211 D. H. Hill Library; E-16 McKimmon Village	2845	834-1529
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*Cole, Dr. James L., Assoc. Prof., Psychology..... 218 Tompkins; Rt. 2, Raleigh	2252	772-0482
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*Collins, Carroll E., Research Asst., N.C.Crop Impr. Assn.....	2851	828-2037
189 Williams; 100-3 Horne St.		
*Collins, David L., Deliveryman, Print Shop.....	2131	
1927 Rock Quarry Rd.		
*Collins, Dr. Emerson R., Prof. Emeritus, Agri. Ext.....	2802, 2803	832-9715
203 Ricks; 2713 Rosedale Ave.		
*Collins, John N., Ext. Inst., Sociology & Anthropology.....	2659	552-5748
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*Collins, Dr. William K., Assoc. Prof., Crop Science.....	2641	787-8569
454 Williams; 4921 Carteret Dr.		
*Combs, Dr. Joseph J., Director, Health Services, Div. of....	2410	787-9032
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*Combs, Russel C., Instructor, Physical Education.....	2487	833-2902
241 Carmichael; 519 Bashford Rd.		
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12 D. H. Hill Library; 113 Ashe Ave.		
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9 Holladay; 4315 Leesville Rd., Apt. 14-C		
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157 Harrelson; 2130 Cowper Dr.		
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*Cuthbertson, Dianne, Statistical Analyst, Genetics.....	2285	834-9598
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*Daggerhart, Diane, Steno, Economics.....	2604	832-2228
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*Dahiya, Dr. Raghunath S., Asst. Prof., Food Science.....	2795	834-0242
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*Dail, Asa L., Linotype Oper., Print Shop.....	2131	496-4896
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*Dalrymple, Billy C., Food Service Dir., Erdahl-Cloyd Union, ..	2498	787-1243
Div. of Stu. Affairs; Union; 5008 Oak Park Rd.		
*Dalton, Douglas R., Agri Res. Asst., Dairy Husb., Animal.....	2766	834-7505
Science: 241 Polk; 4421 North Blvd.		
*Danby, Dr. J. M. Anthony, Prof., Mathematics.....	2370	787-6018
209 Ramblewood Dr., Apt. 140		
*Dandridge, Dr. Edmund P., Jr., Assoc. Prof., English.....	2464	787-2703
112 Winston; 4316 Galax Dr.		
Daniel, Donna F., Typist, Photocopy Dept., Library.....	2596	832-5997
27 D. H. Hill Library; 2428 Remington Rd.		
*Daniel, Dorsey W., Research Asst., Crop Science.....	2657	922-6191
192 Williams; 309 Damon, Clayton		
*Daniel, Harry T., Info. Specialist, Economics.....	2600	828-2067
205 Patterson; 5207 Melbourne Rd.		
Daniel, Justice G., Driver Trainer, Continuing Education....	2268	556-3666
Blue Ridge Rd, Raleigh; 638 Wait Ave., Wake Forest		
*Daniel, Nola P., Key Punch Oper., Dairy Records Pro. Cen.....	2632	556-5743
Animal Sci.: West End Basement, Leazar; Rt. 2, Wake Forest		
*Daniel, William L., Research Tech., Economics.....	2611	832-2393
18 Patterson; 2321 Grant Ave.		
*Danieley, Audrey Y., Typist II, Registration & Records.....	2435	833-8983
7 Peele; 2510 Stafford Ave.		
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115 Coliseum; 1716 Simpkins St., Apt. A.		
*Danielopoulos, Stylianus D., Instructor, Physics.....	2515	828-9740
406-A Gen. Lab Bldg.; 204 Park Ave.		
*Daniels, Jerry M., Instructor, Physical Education.....	2487	787-1734
227 Carmichael; 3700 Horton St.		
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387-A Williams; 713 Griffis St., Cary		
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*Daughtry, Billy I., Argi. Research Asst., Plant Pathology....	2721	922-6687
2415 Gardner; 103 Second St., Clayton		
*Daughtry, J. A., Agri. Research Asst., Plant Pathology.....	2735	934-4092
2521 Gardner; Smithfield		
*Daughtry, Jack S., Research Asst. IV, Soil Science.....	2645	467-8572
408 Williams; Rt. 1, Box 120, Cary		
*Dauterman, Barbara A., Research Tech., Soil Science.....	2636	787-1626
306 Williams; 4227 Arbutus Dr.		
*Dauterman, Dr. Walter C., Assoc. Prof., Entomology.....	2275	787-1626
4623 Gardner; 4227 Arbutus Dr.		
*Davenport, Dr. Donald G., Assoc. Prof., Animal Science.....	2766	787-2681
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360 Williams; 3704 Avent Ferry Rd.		
Davidson, Harriett A., Secretary, Soil Science.....	2643	828-3978
226 Williams; 612 Chappell Dr.		
+Davidson, Merle, Office Manager, Laundry & Cleaners.....	2122	787-7220
Laundry; 3939 Glenwood Ave.		
*Davis, Dr. A. Clarke, Asst. Prof., Sociology & Anthropology..	2702	787-1751
337 1911 Bldg.; 4213 Boxwood Rd.		
*Davis, Daphne D., Asst. Research Tech., Plant Pathology.....	2735	828-4133
2610 Gardner; 3500 Winton Rd.		
*Davis, Dr. David E., Prof. & Head, Zoology.....	2741	787-2541
2123 Gardner; 211 Fairview Rd..		
Davis, Dolly E., Secretary, Botany.....	2227	834-2485
3205 Gardner; 1808-D Carson St.		
*Davis, Elmo L., Driver Trainer, Continuing Education.....	2266	833-6305
1911 Bldg; 1206 Williamson Dr.		
*Davis, H. L., Foreman, Bindery.....	2169	833-1516
Leazar; 516 Peebles St.		
*Davis, Dr. H. Mauzee, Adj. Prof., Metallurgical Engr.....	2377	929-2448
108-C Page; Chapel Hill		
*Davis, Jack L., Driver Trainer, Continuing Education.....	2266	772-0208
113 1911 Bldg.; 1011 Barbara Dr., Garner		
*Davis, Lewis J., Maint. Mech., Textiles.....	2578	556-3844
301 Nelson; 637 N. Main St., Wake Forest		
*Davis Philip H., Assoc. Prof., English.....	2464	832-4827
109 Winston; 814 Woodburn Rd.		
*Davis, Walter H., Research Suprv., Crop Science.....	2657	834-7551
139 Williams; 2332 Millbank St.		
Davis, Dr. William R., Prof., Physics.....	2513	833-0206
410-E Gen. Lab Bldg.; 510 Jefferson St.		
*Davison, Harold L., Instructor, Mathematics.....	2385	467-1952
229 Harrelson; 921 Cindy St., Cary		
*Dawson, Cleburn G., Instructor, Sociology & Anthropology....	2701	772-4560
330 1911 Bldg.; 305 Loop Rd., Garner		
Day, Paula M., Clerk, Bio. & Agri. Engineering.....	2694	834-0914
100 Bio. & Agri. Engr. Bldg.; 1211 Wake Forest Rd.		
Day, Vivian K., Secretary, Continuing Education.....	2261	833-2315
124 1911 Bldg.; 2510-B Clark Ave.		
Dayton, Madeline L., Secretary, Ext. Horticultural Sci.....	2686	787-6066
227 Kilgore; 1004 Canterbury Rd.		
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190 Williams; 1513 West Chester Rd.		
*DeArmond, Dr. M. Keith, Asst. Prof., Chemistry.....	2538	787-5579
115 Withers; 3621 Corbin St.		
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3709 Hillsborough St.; Rt. 3, Box 640-A, Simpkins Rd.		
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Health; 214 David Clark Lab; 1119 Pender St.		
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320 Ricks; 4125 Yadkin Dr.		
*Deese, Anna G., Secretary, Chemistry.....	2549	833-2906
108 Withers; O-122 McKimmon Village		
*Della, Thomas W., Instructor, Computing Center.....	2518	787-5527
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*Dobson, Samuel H., Ext. Prof., Agronomy Ext.,Crop Science....2639 152 Williams; 2128 Buckingham Rd.		787-7925
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*Dorsey, Alice W., Secretary, Liberal Arts.....2467 161 Harrelson; 5005 Auburn Rd.		782-0583
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*Drew, Barbara J., Steno, Research.....2117 211 Daniels; 616-B Sunnybrook Rd.		
*Drewes, Dr. Donald W., Assoc. Prof., Psychology.....2252 26 Tompkins; 4209 Boxwood Rd.		787-3319
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Dunaway, Cleta E., Library Asst., Catalog, Library.....2598 109 D. H. Hill Library; Rt. 8, Box 208, Raleigh		787-2038
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*Dyer, Vivian P., Agri.Research Asst.,Plant Pathology Ext....2712 1300 Gardner; Selma Rd., Wendell		365-7273
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Peru Contract: 1 Patterson; Peru		
Eckard, Alan L., Health Physics & Process Control Tech.....	2323	833-3701
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*Eckels, Dr. Arthur R., Prof., Electrical Engineering.....	2376	787-5911
316 Daniels; 1417 Dellwood Dr.		
*Edgerton, Helen T., Typist, Photocopy Dept., Library.....	2596	772-1703
27 D. H. Hill Library; Garner		
*Edgerton, Moretta D., Accounting Clerk, N.C.Crop Impr. Assn..	2851	772-2825
193 Williams; 3902 Vesta Dr.		
*Edsall, Dr. Preston W., Prof., Politics.....	2482	832-1698
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137 Bio. & Agri. Engr. Bldg.; 823 Merrie Rd.		
*Edwards, Earle L., Head Football Coach, Athletics.....	2103	834-2657
115 Coliseum; 613 Dixie Tr.		
Edwards, Ellis C., Research Asst., Soil Science.....	2636	
310 Williams; 106 Logan Ct.		
*Edwards, Howard E., Jr., Lithographic Pressman, Agri. Info...	2791	365-7467
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Edwards, J. R., Supt., Mountain Research Station, NCDA....	456-3943	456-6530
Box 167, Waynesville		
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*Edwards, Dr. John A., Assoc. Prof., Engineering Mechanics....	2342	833-0624
323 Riddick; 1501 Franklin Rd.		
*Edwards, Lynda, Secretary, Economics.....	2258	834-6302
18 Patterson; 4812 Smith Dr.		
*Edwards, Mary M., Steno II, Registration & Records.....	2435	787-3996
7 Peele; Rt. 1, Raleigh		
*Edwards, Samuel R., Asst Ext. Editor, Agricultural Info.....	2806	
317 Ricks; 2315 Sonora St.		
*Edwards, Sylvia G., Steno, Economics.....	2606	828-9539
201 Patterson; 1309 Ashburton Rd.		
*Edwards, Tommie D., Research Supvr., Entomology.....	2832	833-6228
3314 Gardner; 823 Merrie Rd.		
*Edwards, William E., Agri. Research Asst, Animal Science.....	2758	
Randleigh Farm; Rt. 2, Raleigh		
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205 Brooks; 219 Hawthorne Rd.		
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105 Harrelson; 517 Tartan Cir.		
*Eisen, Dr. Eugene J., Assoc. Prof., Animal Science.....	2769	787-6955
226 Polk; 308 Northfield Dr.		
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201-C Patterson; Rt. 2, Farrington Rd., Chapel Hill		
Elkan, Dr. Gerald H., Assoc. Prof., Microbiology.....	2392	834-2727
4521 Gardner; 606 Stacy St.		
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316 1911 Bldg.; 409 Webster St., Cary		
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112 Williams; Rt. 4, Box 669, Raleigh		
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2518 Gardner; 324 Shepherd St.		
*Ellis, Hazel B., Accounting Clerk, Business Affairs.....	2153	772-3338
10 Holladay; 5500 Old Stage Rd.		
*Ellis, Howard M., Ext. Prof., Ext. Bio. & Agri. Engr.....	2675	787-2966
200 Bio. & Agri. Engr. Bldg.; 3421 Caldwell Dr.		
*Ellis, Nancy G., Key Punch Oper., Dairy Records, Animal Sci..	2632	
West End Basement, Leazar; Rt. 1, Wendell		
Ellis, Ronald G., Jr., Photo Asst. Visual Aids,	2862	828-5037
Agri. Info.; 3 Ricks; Downtown Plaza		
*Ellwood, Dr. Eric L., Prof. & Head, Wood Sci. & Tech....	2883,2884	787-2895
166 Kilgore; 4505 Pitt St.		
*Elmaghraby, Dr. Salah E., Prof., Oper. Research & Ind. Engr..	2350	782-0808
322-A Riddick; 4315 Leesville Rd., Apt. 32-D		
El-Sharkawy, Dr. Taha A., Research Assoc., Plant Pathology...	2735	833-3449
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284 Williams; 5100 Avent Ferry Rd.		
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104 Peele; 1208 Duplin Rd.		
+Emory, Marcella B., Steno, Adult Education.....	2818	828-3146
109 Ricks; 606 Gardner St.		
Emrick, Dawn, Steno, Economics.....	2609	787-1405
215 Patterson; 4724 Lakemont Dr.		
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Lake Wheeler Rd.; Rt. 3, Raleigh		
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225 Polk; 122 Faircloth St.		
*Etheredge, Robert W., Jr., Architect, Peru Contract.....	2671	
1 Patterson; Peru		
*Evans, Dr. James B., Prof. & Head, Microbiology.....	2391	787-6760
4515-B Gardner; 1413 Dellwood Dr.		
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406-G Gen. Lab Bldg.; 3522 Carriage Dr.		
Evers, Jimmie W., Instructor, English.....	2463	832-9682
221-23 Winston; Western Manor, Apt. F-5		
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209 Brooks; 2109 St. Mary's St.		
*Eycke, Carl O., Director, Student Activities, Div. of	2441	833-0061
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*Farmer, Kay K., Steno, Experimental Statistics..... 612 Gen. Lab Bldg.; 2306 McMullan Cir.	2531	834-7931
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109 D. H. Hill Library; 2377 Champion Ct.		
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Civil Engr.; West Entrance, Watauga; 1412 Canterbury Rd.		
*Mann, Helen O., Admin. Secretary, Chancellor's Office.....	2191	833-8872
A Holladay; 2307 Lyon St.		
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3513 Gardner; 710 Runnymede Rd.		
*Manning, Dr. Charles R., Jr., Assoc. Prof., Mineral Ind.....	2377	
109 Page; 4812 Connell Dr.		
*Manning, Edward G., Assoc. Prof., Electrical Engr.....	2330	834-3007
434 Daniels; 2913 Anderson Dr.		
+Manning, Elizabeth H., Instructor, Chemistry.....	2547	787-5709
216 Withers; 1306 Rand Dr.		
Manning, Judy K., Secretary, Mathematics.....	2386, 2370	834-1050
324 Harrelson; Rt. 3, Melbourn Rd., Raleigh		
*Manning, Dr. R., Visiting Asst. Prof., Peru Contract....	2671, 2672	
1 Patterson; Peru		
*Manring, Dr. E. R., Prof., Physics.....	2513	787-6855
411 Gen. Lab Bldg.; 1601 Dixie Tr.		
*Manson, Dr. Allison R., Asst. Prof., Exp. Statistics.....	2531	833-9663
614-D Gen. Lab Bldg.; 5124 Norman Pl.		
+March, Elsa W., Ext. Secretary, Com. Dev. & Soc. & Anth.....	2659	833-7293
241 1911 Bldg.; 1426 Park Dr.		
Marin, Carmen M., Director, Tob. Lit. Service, Library.....	2836	828-8755
205 D. H. Hill Library; 2307 McMullan Cir.		
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21 Kilgore; 1805 Bellwood Dr.		

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*Marshall, Henry V., Jr., Supt. in Charge, Univ.....	2823, 2824	833-1394
Research Farms; 1-B Patterson; 5120 Kaplan Dr.		
Marshall, Pamela N., Secretary, Ind. Engr. & Oper. Res.....	2350	
322-A Riddick; 3939 Glenwood Ave., Apt. 250		
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*Marsland, Dr. David B., Assoc. Prof., Chemical Engr.....	2325	834-1479
103 Riddick; 205 Forest Rd.		
*Martin, Dr. Clifford K., Asst. Prof., Soil Science.....	2389	834-3917
366 Williams; 412 Dixie Tr.		
*Martin, David H., Asst. Prof., Physics.....	2525	834-0013
100 Nuclear Lab; 820 Merrie Rd.		
*Martin, Dr. Donald C., Assoc. Prof., Chemical Engr.....	2326	834-4438
206 Riddick; 820 Carlisle St.		
*Martin, Donald C., Assoc. Statistician, Exp. Stat.....	2541	682-5806
504 Gen. Lab Bldg.; 611 West Markham, Durham		
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451 Williams; 3501 Turnbridge		
*Martin, Dr. Grady A., Ext. Assoc. Prof., Poultry Science.....	2621	833-6792
209 Scott; 3405 Ruffin St.		
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*Martin, Nancy B., Steno, Textile Chemistry.....	2553, 2555	787-7470
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*Martin, Sarah H., Typist II, Entomology.....	2749	832-7033
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2113 Gardner; 2705 Trawick Rd.		
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205 Patterson; 2227 The Circle		
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+Mason, Edna Belle, Admn. Secretary, Civil Engineering.....	2331	832-3994
208 Mann; 113½ Chamberlain St.		
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101 Ricks; Boylan Apts., F-201		
*Mason, Freida D., Steno I, Rec. & Park Admin.....	2247	832-8577
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136 1911 Bldg.; 1324 Lutz Ave.		
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614-A Gen. Lab Bldg.; 3525 Allendale Dr.		

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Stu. Affairs; 210 Peele; 2240 The Circle		
*Massengill, Dr. George K., Physician, Health Service, Div....	2410	832-8493
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*Massey, Frances W., Instructor, Textile Technology.....	2558	828-8128
B-49 Nelson; 1301 Fairfax Dr.		
*Massey, Shirley B., Data Processor, Computing Center....	2519, 2518	772-1863
Nelson Textiles; 505 Ranch Farm Rd.	2510	
*Masterton, Don A., Assoc. Prof., Product Design.....	2205	828-6508
317 Brooks; 1013 Jones-Franklin Rd.		
*Mathia, Dr. Gene A., Assoc. Prof., Ext. Agri. Econ.....	2606	787-7359
201 Patterson; 4124 Laurel Hills Rd.		
*Mathieu, Mrs. Pat, Statistical Analyst, Genetics.....	2285	834-6981
3632 Gardner; 108 Ashe Ave.		
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331 Williams; 811 Brent Rd.		
*Matrone, Dr. Gennard, Reynolds Prof. & Head, Biochemistry....	2681	787-5731
339 Polk; 1333 Duplin Rd.		
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14 Ricks; 3306 Pine Grove Rd.		
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254 Kilgore; 223 W. Drewry Ln.		
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213-A Ricks; 4125 Camelot Dr.		
*Mattox, John D., Photographer, Visual Aids, Agri. Info.....	2862	365-5231
7 Ricks; 305 Wall St., Wendell		
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3636 Gardner; 3413 Doyle Rd.		
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3204 Clark Ave.		
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Animal Science; Leazar; Rt. 3, Box 109, Apex		
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123 Tompkins; 1700 Dare St.		
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212-B Brooks; 5112 Wickham Rd.		
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360 Harrelson; 1317 Kimberley Dr.		
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West Entrance Watauga; 12½ Enterprise St.		
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518 Gen. Lab Bldg.; 3906 Lexington Dr., Apt. B		
*McBrayer, Elizabeth M., Steno, Food Science.....	2796	832-0479
126 Polk; 223 Forest Rd.		
*McCabe, Eugene, Research Asst. IV, Genetics.....	2287	833-9539
2525 Gardner; 3820 Sherman Ave.		
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121 Riddick; 222 Ransom St., Chapel Hill		
*McCann, Dr. Glenn C., Prof., Sociology & Anthropology.....	2702	834-4403
338 1911 Bldg.; 713 Barksdale Dr.		
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424 Williams; 201 Merwin Rd.		
McCarter, Jean M., Library Asst., Circulation Dept., Library..	2845	833-5479
106 D. H. Hill Library; 2724½ Clark Ave.		
McCarthy, Larry A., Printer, Print Shop.....	2131	834-2905
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128 Harrelson; 3704 Horton St., Apt. 102		
McClenny, Nancy, Agri. Tech., Plant Pathology.....	2735	828-2919
2610 Gardner; 839 Bryan St.		
*McClure, William F., Asst. Prof., Bio. & Agri. Engr.....	2682	833-8927
116 Bio & Agri. Engr. Bldg.; 828 Merrie Rd.		
*McCullough, H. B., Asst., Athletics.....	2103,2104	834-2127
115 Coliseum; 3719 Swift Dr.		
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386 Williams; 4921 Liles Rd.		
McCollum, Ronald E., Agri. Research Asst., Crop Science.....	2647	833-0035
290 Williams; Rt. 8, Box 69-B, Raleigh		
*McCombs, Dr. Clarence L., Prof., Horticultural Science.....	2689	787-6308
220 Kilgore; 3438 Bradley Pl.		
*McConnell, Norman J., Agri. Research Supvr., Poultry Sci.....	2729	833-4788
Poultry Farm; 1403 Varsity Dr.		
*McCoy, Richard F., Custodian, Military Property, Div. of.....	2427	833-4732
Stu. Affairs; Frank Thompson Bldg.; Rt. 5, Box 378, Raleigh		
*McCracken, Dr. R. J., Prof. & Hear, Soil Science.....	2655,2656	467-1233
222 Williams; 1025 Warren Ave., Cary		
*McCullers, James L., Bindery.....	2169	833-3398
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*McCulloch, Sandra B., Secretary, Tob. Lit. Service,.....	2836,2837	833-2395
205 D. H. Hill Library; G-23 McKimmon Village		
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1234 Gardner; 3811 Cobb St.		
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228 Tompkins; 1305 Ivy Ln.		
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119 Riddick; 3120 Tanager St.		
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McDowell, Frances S., Research Tech., Biochemistry.....	2586	782-0985
3 Withers; 152 Beckanna Apts.		
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236 Harrelson.		
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122 D. H. Hill Library; 408 Glascock St.		
*McGee, Curtis D., Research Asst.III, Crop Science.....	2657	
182 Williams; Rt. 1, Box 144, Cary		
*McGee, Floyd G., Agri. Research Asst. Hort. Science.....	2683	772-1182
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*McGlamery, Edith B., Ext.Housing & House Furn.Spec., Agri.Ext..	2785	834-9604
211 Ricks; 210 Wilmont Dr.		
*McGlamery, Rev. Neal V., Methodist Chaplain, Religious...	833-1861	834-9604
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111 Polk; 5012 Huntingdon Dr.		
*McIntosh, Violet E., Steno III, Genetics.....	2291	833-5748
3513 Gardner; 614 Stacy St.		
*McIntosh, William A., Instructor, Ind. & Tech. Education....	2241	467-8260
111-B Tompkins; 509 Page St., Cary		
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228 Tompkins; 604 Maynard Rd., Cary		

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120 Bio. & Agri. Engr. Bldg.; 101 Meadow Dr., Cary		
*McLamb, Ralph D., Agri. Research Supvr., Animal Disease.....	2738	467-1226
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*McLamb, Shelton D., Shipping Clerk, Print Shop.....	2131	
Dan Allen Dr.; Rt. 1, Benson		
*McLaughlin, Foil W., Ext. Assoc. Prof., Crop Sci. & Dir.,.....	2851	787-6991
N.C. Crop Imp. : 193 Williams; 804 Runnymede Rd.		
*McLaurin, Winborne R., Research Asst., Forest Resources.....	2881	467-4241
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McLean, David W., Jr., Data Processing Mgr., Reg. & Rec.....	2444	832-2458
4 Peele; 808 Brighton Rd.		
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3 Holladay; 15 Enterprise St.		
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*McMahon, Gloria B., Secretary, Soil Science.....	2389	832-0486
356 Williams; 2408 Mayview Rd.		
*McMillen, R. W., Manager, N.C. Foundation Seed Prod., Inc.....	2821	787-6507
124 Williams; 3008 Grant Ave.		
*McMurray, Allen L., Agri. Research Tech., Hort. Science.....	2660	833-1119
212 Kilgore; Rt. 4, Box 114, Raleigh		
+McNally, Manila S., Housemother, Sigma Phi Epsilon Frat.....	828-7088	
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343 Polk; 305 W. Forest Dr.		
McSwain, Clyde Z., Jr., Supt., Piedmont Res. Station.....	278-2624	278-2862
N.C.D.A.; Rt. 6, Salisbury		
*McSwain, Jeannette H., Secretary, Agri. & Life Science.....	2615	365-7704
111 Patterson; Box 184, Wendell		
*McVay, Dr. Francis E., Prof., Experimental Statistics.....	2531	787-5632
612-B Gen. Lab Bldg.; 3119 Darien Dr.		
*McVay, Mrs. J., Instructor, Mathematics.....	2386	787-5632
333 Harrelson; 3119 Darien Dr.		
*Meacham, Frank B., Ext. Asst. Beekeeper, Entomology.....	2703, 2831	832-0606
2314 Gardner; 2716 Everett Ave.		
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+Medlin, Louise, Snackbar Asst., SSS.....	2161	833-7228
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128 Williams; 2915 Wade Ave.		
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309 Ricks; Apt. H, 141 Jones-Franklin Rd.		
*Memory, Dr. Jasper D., Prof., Physics.....	2513	787-0158
410 Gen. Lab Bldg.; 5014 Hollyridge Dr.		
*Menius, Dr. Arthur C., Dean, Physical Sci. & Appl. Math....	2501, 2502	787-3520
115 Gen. Lab Bldg.; 541 Hertford		
*Mercer, Dr. Charles V., Assoc. Prof.; Sociology & Anth.....	2701	833-5442
328 1911 Bldg.; 712 Beaver Dam Rd.		
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*Mercer, Sam, Instructor, Forest Resources.....	2887	467-8726
52 Kilgore; 1009 Plantation Dr., Cary		
+Merritt, Emily W., Accounting Clerk, Bookkeeping.....	2149	832-1002
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*Mezynski, Stanley, Glass Technologist, Physics.....2505 205 Daniels; 1209 N. King Charles Rd.		828-0270
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*Michie, Capt. Richard L., Asst. PMS, Army ROTC.....2428 Div. of Stu. Affairs; 154 Coliseum; 512 Tarton Cir., Apt. 24		828-4148
*Mickey, Rev. Edward T., Moravian Chaplain, Rel. Affairs..787-4034 Div. of Stu. Affairs; 3225 Darien Dr.		787-4191
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*Middleton, Henry M., Asst. Prof., Knitting Technology.....2573 133 Nelson; 2208 Creston Rd.		833-8636
*Middleton, J. Leonard, Assoc. Prof., Phil. & Religion.....2477 348 Harrelson; 903 Runnymede Rd.		787-6269
*Middleton, James I., Dairy Plant Mgr., Food Science.....2700 Polk; Rt. 1, Garner		772-4437
*Miles, Dr. Marion L., Asst. Prof., Chemistry.....2524 201 Withers; 4021 Huckleberry Dr.		787-3352
*Milholland, Dr. Robert D., Ext. Asst. Prof., Plant Path..675-2314 Hort. Crops Res. Sta., Castle Hayne; 4025 Gillette, Wilmington		762-3834
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*Miller, Dr. Howard G., Prof., Psychology.....2251 201 Tompkins; 3411 Noel Ct.		787-6039
*Miller, Latham L., Assoc. Prof., Recreation & Park Admin.....2246 Field House; 1316 Glen Eden Dr.		787-4464
*Miller, Mitzi G., Research Inst., Chemistry.....2548 15 Withers; 1103 Parker St.		828-2977
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*Miller, Patricia B., Steno III, Entomology.....2274,2275,2276 4620 Gardner; 3548 Apache Dr.		828-3792
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*Miller, Dr. William D., Prof. Emer. Silverculture, Forest Mgmt..... 1907 Victoria Rd.		782-0722
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211 Scott; Rt. 2, Apex		
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Equipment Room, Carmichael		
*Mingis, Nancy C., Agri. Res. Tech., Nut. & Biochem., Ani. Sci.....	2773	832-8660
329 Polk; C-5, 4421 North Blvd.		
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4614-A Gardner; 2606 Kilgore Ave.		
+Mintz, Catharine W., Secretary, Student Publications, Div.....	2412	833-1198
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*Mintz, Colin S., Dist. Ext. Chairman, Agricultural Extension...	2780	833-8586
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*Mirza, Dr. Jehangir F., Asst. Prof., Civil Engineering.....	2334	832-0935
413 Mann; 2803 Van Dyke Ave.		
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*Mitchell, Adolphus, Prof., Engineering Mechanics.....	2343	834-7658
221 Riddick; 2609 Bellevue Rd.		
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+Mitchell, Mary Frances, Personnel Clerk, Physical Plant.....	2181	833-1396
200 Morris; 605 North Blount St.		
*Mitchell, Sanora K., Typist II, Art & Exhibits.....	2807	787-9586
313 Ricks; 4315 Leesville Rd.		
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234 Daniels; 3939 Glenwood Ave.		
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328 Williams; 903 Warren Ave., Cary		
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242 Polk; 505 S. Dixon Ave., Cary		
*Moeller, Dr. Carl A., Assoc. Prof., Ind. & Tech. Edu., (Ind. Arts)..	2237	834-5437
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Tugman, Dasa F., Supt., Upper Mtn. Res. Station, N.C.D.A., Laurel Springs	982-2501	982-2506
*Tunstall, Lena F., Secretary, Animal Science..... 231 Polk; 2814 Mayview Rd.	2768	833-1627
*Tunstall, Shelton, Res. Supvr., Genetics..... 2619 Gardner; 1014 Norris St.	2289	833-5545
*Turner, Anna L., Book Binder..... Leazar; Rt. 2, Poole Rd.	2169	834-8324
Turner, Anne L., Chief Bibliographer, D.H.Hill Library..... 108 Library; 903 West Johnson St.	2598	832-6997
+Turner, Bessie B., Operator, Telephone Services..... 116 Winston; 5133 Norman Place	0	828-2982
*Turner, Dr. Carl B., Assoc. Prof., Economics..... 210 Patterson; Candlewood Dr., Rt. 6	2600	787-8234
*Turner, David W., Asst. Statistician, Expt. Statistics..... 614-A Gen. Lab Bldg.; 5649 Hillsborough St.	2531	828-8180
*Turner, Vance R., Res. Tech., Crop Science..... 488 Williams; 3900 Kelly St.	2720	772-0119
*Turner, Dr. William L., Admn. Dean for Univ. Ext..... 140 1911 Bldg.; 3337 Thomas Rd.	2144	787-0662
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Ullrich, Dr. D. F., Asst. Prof., Mathematics..... 338 Harrelson; 4315 Leesville	2370	787-9128
Umstead, Carlisle, Agri. Res. Asst., Plant Pathology 2408 Gardner; 2800 Bedford Ave.	2722	832-1251
*Underwood, Von Harvey, Instructor, Horticultural Sci..... 234 Kilgore; 332 Dry Ave., Cary	2669	467-1928
Upchurch, Marilyn M., Instructor, English..... 209 Winston; 707 Beaver Dam Rd.	2463	828-2431
*Upchurch, Woody, Acting News Editor, Agri. Infomation... 316 Ricks; Rt. 1, Box 365-A, Garner	2805, 2809	772-2535
*Usanis, Richard A., Stat. Anal., Genetics..... 3632 Gardner; 2608 Mayview Rd.	2285	828-0046
*Usanis, Sharon A., Geneticist, (USDA-ARS), Genetics..... 112 Williams; 2608 Mayview Rd.	2638	828-0046
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513-A Gen. Lab Bldg.; 1212 Brooks Ave.		
*Vanderwall, Dr. William J., Instructor, Engr. Graphics.....	2387	772-4796
273 Broughton; 1509 St. Patrick Dr.		
*Vaughan, Dianne O., Steno II, Inst. of Biological Sci.....	2665	
101 Patterson; Rt. 1, Box 144, Cary		
*Verghese, Dr. Kuruvilla, Asst. Prof., Nuclear Engr.....	2298	467-1922
235 Riddick; 1228 Kingston Ridge Dr., Cary		
*Vermillion, Janet E., Steno II, Design.....	2203	833-5007
317 Brooks; 504 Culpepper Cir.		
*Vestal, SSG Allen L., Asst. Oper. Sgt., Army ROTC, Div. of...	2428	467-1274
Stu. Affairs; 154 Coliseum; Rt. 1, Box 556, Cary		
*Vestal, Thomas J., Agri. Res. Tech., Animal Disease Sect.....	2738	832-5638
Animal Disease Lab; 722 Wimbleton		
*Via, R. Banks, Data Processor II, Registration & Records....	2444	832-2282
Peele		
*Vick, Mary C., Library Asst., Acquisitions Dept., Library.....	2841	833-0720
112 D. H. Hill Library; 2373 McMullan Cir.		
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612 Gen. Lab Bldg.; Box 752-44, Hi-House Tr. Pk., Cary		
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428 Williams; 2213 Noble Rd.		
Waddail, M. Ellen, Key punch Oper., Dairy Rec. Proc. Cen., Animal....	2632	834-8060
Science: West End Basement, Leazar; Rt. 5, Foxcroft		
Wade, Virginia, Res. Supvr., Entomology.....	2749	832-4114
3709 Hillsborough St.; 2415 Everett Ave.		
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203 Ricks; 1318 Lutz Ave.		
*Wagoner, Thomas L., Agri. Res. Asst., Animal Science.....	2673	985-4024
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*Wahl, Dr. George H., Jr., Asst. Prof., Chemistry.....	2524	787-8916
201 Withers; 3422 Leonard St.		
*Wahls, Dr. Harvey E., Assoc. Prof., Civil Engr.....	2334	787-0585
215 Mann; 4712 Glen Forest Dr.		
*Waldo, Dr. Dale R., Res. Assoc., Expt. Statistics.....	2282	833-0306
1515-A Gardner; 367 Meredith St.		
*Waldrep, Dr. Thomas W., Asst. Prof., Crop Science.....	2642	833-8885
430 Williams; Rt. 8, Box 69-A, Raleigh		
*Walker, Edward, Clerk Messenger, D. H. Hill Library.....	2842	833-4332
Receiving Room, Library; 705 Bunche Dr.		
*Walker, Dr. James L., Vis. Asst. Prof. Int. Soil Testing.....	2277	
Soil Science.; Guatemala, C. A.		
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West End Basement, Leazar; 3337 Priartuck Rd.		
*Wallace, Gail S., Typist, Acquisitions Dept., Library.....	2841	832-5793
112 D. H. Hill Library; 811½ Glenwood Ave.		
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149 Harrelson; Kings Mill Rd., Chapel Hill		
*Wallace, Mary A., Supervisor, Business Affairs.....	2148	832-9888
103 Holladay; 2371 Champion Ct.		
*Wallace, Dr. T. Dudley, Prof., Economics & Statistics.....	2604	834-2352
201-B Patterson; 1401 Lorimer Rd.		
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IES Bldg.; 2725 Conifer, Apt. C		
*Waller, Jerry M., Instructor, Metallurgical Engr.....	2377	467-1396
106 Page; 904 Kathryn St., Cary		
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7-9 Winston; 3929 Arrow Dr.		
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1718 Hillsborough St.		
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S-53 Nelson; 2622 Bedford Ave.		
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312 Polk; 2128 Cowper Dr.		
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218-20 Winston; 5211 Melbourne Rd.		
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402 Gen Lab Bldg.; 1204 Westmoreland Dr.		
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204 Polk; 5922 S. Sharon St.		
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4218 Gardner; 903½ Method Rd.		
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101 Coliseum; 612 D Woodburn Rd.		
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306 Ricks; 201½ Groveland Ave.		
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216 Scott; Rt. 8, Box 20-E, Raleigh		
*Ward, Dr. Thomas M., Instructor, Chemsitry.....	2538	787-2996
117 Withers; 2736 St. Mary's St.		
*Warmbrod, G. Karl, Instructor, Mathematics.....	2370	833-4872
313 Harrelson; 102 Horne St.		
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*Warren, Dr. Frederick G., Prof., Food Science.....	2776	787-5116
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518-D Gan. Lab Bldg.; 3113 Birnamwood Rd.		
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123 Polk; 4343 E. Lassiter Mill Rd.		
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2124 Gardner; 804 Merrie Rd.		
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222 Nelson; Rt. 3, Wake Forest		
*Watkins, Rupert W., Ext. Asst. Prof., Ext.Bio. & Agri. Engr....	2675	934-7793
202 Bio. & Agri. Engr. Bldg.; Rt. 1, Box 230, Clayton		
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212 Harrelson; 3134 Sussex Rd.		
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205 King Religious Cen.; 4208 Union St.		
*Watson, James D., Instructor, Mathematics.....	2370	833-0853
313 Harrelson; 3413 Victor Pl.		
*Watson, Larry W., Instructor, Mathematics Edu.....	2239	787-5745
103 Tompkins; 5100 Glen Forest Dr.		
*Watts, Harold, Laundry Supervisor.....	2122	834-5870
Laundry; 307 Marsh Ave.		
*Watts, Norbert B., Director, Stu. Housing, Div. of Stu.Aff....	2406	787-4415
203 Peele; Rt. 8, Box 183, Raleigh		
*Waugh, Dr. Donovan L., Vis.Assoc.Prof., Int.Soil Testing.....	2277	
Soil Science; Lima Peru		
*Weathers, Betty M., Agri. Res. Asst. III, Crop Science.....	2635	834-2410
402 Williams; 933 Friar Tuck Rd.		
*Weathers, Clyde R., Ext. Prof., Economics.....	2724	467-9268
220-F Patterson; 614 Union St., Cary		
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207-A Holladay; 1336 Canterbury Rd.		
*Weathers, Johnny O., Dupl. Oper. II, Agri. Information.....	2791	828-7119
21 Ricks; 1315 Filmore St.		
*Weathers, Laura R., Steno II, Entomology.....	2620	266-2200
2301 Gardner; Rt. 2, Wendell		
*Weathers, Phyllis M., Typist, Economics.....	2473	828-7119
128 Harrelson; 1315 Filmore St., Apt. C		
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109 Bio. & Agri. Engr. Bldg.; 414 Morrison Ave.		
*Weaver, Merle C., Typist II, Records.....	2435	828-3574
7 Peele; 2833 Claremont		
*Weaver, Peggy C., Receiving Clerk, Dairy Rec.Proc.Cen., Ani.Sci..	2632	832-6781
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271 Broughton; 5117 Kaplan Dr.		
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324 Williams; 5036 New Castle Rd.		
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124 Coliseum; 2304 Mayview Rd.		
*Weckman, Dr. Gerald T., Assoc. Prof. In Charge Ent. Ext..	2703, 2831	787-7400
2309 Gardner; 909 Emory Lane		
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216 Page; 805 Davidson St.		
Weich, Debra J., Steno I, Mathematics.....	2386	
324 Harrelson; Rt. 3, Fuquay-Varina		
Weich, Paulett, Steno II, Engr. Dean's Office.....	2315, 2316	552-4649
232 Riddick; Rt. 3, Box 439, Fuquay-Varina		
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2418 Gardner; 1504 Ridge Rd.		
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139 Polk; K-3-B Cameron Ct.		
*Wells, J. C., Ext. Prof., Plant Pathology.....	2711	833-6040
1405 Gardner; Box 16, Rt. 8, Raleigh		
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18 Patterson; 5228 Melbourne Rd.		
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3406 Gardner; 745 Catawba St.		
*Wernsman, Dr. Earl A., Asst. Prof., Crop Science.....	2642	828-8343
429-A Williams; 211 Merwin Rd.		
*Wescott, James B., Instructor, Physical Education.....	2487	755-2913
218 Carmichael; 214-C Bragaw Dorm., NCSU		
Wesler, Dr. Oscar, Prof., Expt. Statistics & Math.....	2531	832-6943
614-G Gen. Lab Bldg.; 1926 Smallwood Dr.		
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234 1911 Bldg.; F-3 Shelton Apts.		
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201 Scott; 2606 Clark Ave.		
*West, Dr. Donald A., Asst. Prof., Economics.....	2473	787-7388
127 Harrelson; 205 Northfield Dr.		
*West, Harry C., Instructor, English.....	2463	787-1854
217-19 Winston; 1225 Duplin Rd.		
*West, Dr. Jerry G., Visiting Prof., Economics.....	2600	832-4864
210 Patterson; 3211 Ruffin St.		
*West, John R., Instructor, Poultry Science.....	2621	828-7789
214 Scott; 1707 Park Dr.		
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123 Tompkins; 3431 Churchill Rd.		
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200 Brooks; C-24 McKimmon Village		
*Weston, W. F., Jr., Counselor, Div. of Stu. Affairs.....	2424	787-2997
210 Peele; 4116 White Pine Dr.		
*Weybrew, Dr. Joseph A., Wm. N. Reynolds Prof., Crop Sci.....	2635	832-7053
407 Williams; 112 Pineland Cir.		
*Wheeler, Dr. Mary E., Asst. Prof., History.....	2485	787-9244
108 Harrelson; 4923 Grinnell Dr.		
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*Whitaker, Dr. Thomas B., Asst. Prof., USDA-ARS, Bio. & Agri.....	2681	833-6342
Engr.; 127 Bio. & Agri. Engr. Bldg.; 2308 Champion Ct.		
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203 Tompkins; 212 E. Whitaker Mill Rd.		
White, Ray L., Instructor, English.....	2463	
215 Winston.		
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*White, Dr. Robert B., Jr., Asst. Prof., English.....	2464	828-3687
117 Winston; Rt. 1, Holly Dr.		
*White, Robert K., Asst. Dir., Adms., Div. of Stu. Aff.....	2431	467-8355
112 Peele; 910 Pamlico Dr., Cary		
*Whitehurst, Sarah W., Secretary, Dist. Ext. Chairmen.....	2780	467-8440
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*Whitfield, Fred E., Assoc. Spec., Ext. Forestry.....	2891	787-4871
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Whitfield, Hazel B., Clerk, Army ROTC, Div. of Stu. Aff.....	2428	833-1869
154 Coliseum; C-1 Wilmont Apts.		
*Whitfield, John K., Assoc. Prof., Mech. & Aerospace Engr.....	2372	787-1128
319 Broughton; 3605 Swann Dr.		
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4203 Gardner; 3217 Oak Grove Cir.		
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27 D. H. Hill Library; 525 N. Bloodworth St.		
*Whitley, Barbara, Dining Coordinator, ARA Slater.....	2878	772-0819
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428 Williams; 2614 Bedford Ave.		
*Wicker, Linda C., Secretary, Print Shop.....	2131	542-2692
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*Wilburn, R. Craig, Clerk, Agri. Information.....	2791	
6 Ricks; 825 Carlisle		
*Wilcox, Grover B., Truck Driver, Central Stores.....	2198	833-6182
108 Morris; K-21 Washington Terr.		
*Wilder, Isabelle N., Steno-Clerk, Agri. Info., Visual Aids....	2862	834-2929
3 Ricks; 14 Daisy St.		
*Wilder, Ray., Maint. Mech., Plant Pathology.....	2735	365-7228
2518 Gardner; Box 52, Wendell		
*Wiles, Patricia M., Steno II, Entomology Ext.....	2703, 2831	834-4204
2309 Gardner; 5139 Lundy Dr.		
*Wilk, Dr. John C., Assoc. Prof., Animal Science.....	2766	833-0259
232 Polk; Rt. 8, Box 100-D		
*Wilkinson, Ruby W., Steno II, Industrial & Tech Edu.....	2241	833-0895
111-B Tompkins; 805 Culpepper Lane		
*Wilkes, Rose A., Secretary, Agri. & Life Sci.....	2823, 2824	833-1807
1 Patterson; 1802 Pineview St.		
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328 Riddick; S-3 Raleigh Apts.		
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147 Bio. & Agri. Engr. Bldg.; 2737 Rothgeb Dr.		

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118 Ricks; 2610 Cherry Cir.		
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1 Patterson; Peru		
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1912 Lewis Cir.		
*Williams, Dr. Dorothy S., Asst. Prof., Sociology & Anth.....	2701	832-8811
334 1911 Bldg.; Apt. 3-A, Carolina Hotel		
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154 Coliseum; 800 Woodland Rd.		
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212 Polk; 633-B Chapel Dr.		
*Williams, Gertrude H., Steno II, Soils Ext.....	2654	828-7009
155 Williams; 2445 Kennington Rd.		
*Williams, Harvey P., Prof. Emeritus, Mathematics.....	2381	832-2191
213 Harrelson; 1015 Brooks Ave.		
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217-19 Winston; 622 Woodburn Ave.		
*Williams, Milo, Truck Driver, Print Shop.....	2131	
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*Williams, Norman M., Asst. Food Ser. Dir., Div. of Stu. Aff....	2498	833-9917
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3614 Western Blvd.; Rt. 8, Raleigh		
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1313 Gardner; Rt. 1, Whitfield St., Knightdale		
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Expt. Sta. & Agri. Ext. Ser.; 112 Ricks; 2210 Wheeler Rd.		
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32 Burlington Lab; 1096 Nichols Dr.		
*Williamson, Lynell, Stock Clerk, Textile Chemistry.....	2555	832-8056
123 David Clark Lab; 2403 Kilgore Ave.		
+Williamson, Marie E., Steno, Textiles.....	2565	833-2678
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*Williamson, Norman F., Res. Assoc., Expt. Statistics.....	2282	787-8862
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*Willis, Hilda A., Stock Clerk, Chemistry..... 26 Withers; 402 Horne St., Apt. 3	2547	832-3443
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*Wilson, Lucy C., Librarian, Tobacco Literature Ser., Library... 205 D. H. Hill Library; 1101 Lakeside Dr., Garner	2836	772-1822
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*Wise, Dr. George H., Wm. N. Reynolds Prof., Nutri. Bio. Sect... Animal Science; 319 Polk; 229 Woodburn Rd.	2773	833-9262
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*Wise, Dr. Milton B., Prof., Animal Science..... 220-A Polk; 633 S. Lakeside Dr.	2763	828-3319
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*Wiser, Dr. Edward H., Assoc. Prof., Bio. & Agri. Engr..... 148 Bio. & Agri. Engr. Bldg.; 404 Dixie Tr.	2663	834-2114
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*Woltz, Dr. Willie G., Prof., Soil Science..... 426 Williams; Oxford	2645	693-7831

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*Woodlief, Rodney-Ann D., Key Punch Opr., Business Aff.....	2140	828-9944
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2306 Gardner; 2828 Gladstone Dr.		
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*Work, Dr. Robert W., Prof. & Dir. of Res., Textiles.....	2554	787-7722
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4317 Gardner; 4221 Arbutus Dr.		
*Wright, John D., Manager, Business Affairs.....	2155	787-0252
105 Holladay; 4902 Brookhaven Dr.		
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Yarborough, Willie E., Janitor, Print Shop.....	2131	
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212-C Brooks; 2340 Lyon St.		
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4322 Gardner; 612 Buck Jones Rd.		
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2612 Gardner; 2821 Kilgore St.		
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208 Page; 1213 Kent Rd.		
Zimpel, J., Visiting Ext. Spec., Peru Contract.....	2671, 2672	
1 Patterson; Peru		
Zobel, Dr. Bruce J., Prof., Forest Genetics, Forest Mgmt.....	2880	834-0090
252 Kilgore; Holly Springs Rd., Rt. 4, Raleigh		
Zorowski, Dr. Carl F., Prof. & Assoc. Head, Mech. &	2360	787-0937
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Term expires
Sept. 1

J. S. Doolittle, <u>Chairman</u>	1968
W. W. Austin	1968
C. H. Bostian	1968
J. E. Legates	1968
R. J. Monroe	1968

Alternates

W. J. Block	
H. M. Nahikian	
C. C. Scarborough	

FACULTY HOSPITALITY AND ORIENTATION

W. A. Reid, <u>Chairman</u>	
H. D. Berry	
J. B. Edwards	
B. S. Gupta	
R. P. Moore	
C. C. Scarborough	
C. C. Stott	
E. G. Thurlow	
H. E. Wahls	

O. MAX GARDNER AWARD

W. J. Block, <u>Chairman</u>	
W. H. Bennett	
E. L. Ellwood	

W. C. Gregory	
D. M. Hanson	
H. H. Harris	
H. A. Rutherford	
V. T. Stannett	

GOVERNMENT

Term expires
Sept. 1

W. J. Block, <u>Chairman</u>	1968
B. F. Beers	1968
C. L. Bumgardner	1969
H. W. Garren	1969
P. D. Cribbins	1970
A. S. Knowles	1970

GRADUATE SCHOOL ADMINISTRATIVE BOARD

Term expires

W. J. Peterson, <u>Chairman</u>	
D. M. Cates	Aug. 1968
G. W. Poland	Jan. 1968
P. H. McDonald	Jan. 1969
J. E. Legates	Mar. 1969
T. J. Mann	July 1969
J. W. Duffield	Sept. 1969
H. B. Smith	Oct. 1969
H. M. Nahikian	Nov. 1970
R. P. Burns	Mar. 1971
W. O. Doggett	Sept. 1971
H. E. Speece	Nov. 1971

GROUP INSURANCE AND FACULTY WELFARE

D. M. Peterson, <u>Chairman</u>	
K. S. Campbell	
M. H. Clayton	
J. S. Doolittle	
A. H. E. Grandage	
G. A. Gullette	
P. H. Harvey	
D. A. Metzinger (<u>Senate</u>)	
H. A. Shannon	
J. C. Williamson	
R. W. Dittmar (<u>Business Affairs</u>)	

HARRELSON FUND

W. W. Kriegel, <u>Chairman</u>	
H. L. Kamphoefner, Vice-Chmn.	
W. C. Fitzgerald	
J. D. Memory	
S. G. Stephens	

INSTITUTIONAL HISTORY AND NAMING OF BUILDINGS

C. H. Bostian, <u>Chairman</u>	
M. S. Tolar, <u>Secretary</u>	
R. G. Carson, Jr.	
C. B. King	
C. L. Mann, Jr.	
Stuart Noblin	
R. G. Walser	

LIBRARY

Charles Smallwood, <u>Chairman</u>	
E. B. Berry	
M. L. Brown	
C. B. Davey	

M. H. Farrier
 J. J. Harder
 C. A. Hart
 L. C. Hartley
 S. G. Levine
 T. R. Miller
 L. W. Seegers (Senate)
 R. A. Struble
 L. M. Wodehouse
 I. T. Littleton, Ex Officio
 D. S. Keener, Ex Officio
Student Members
 Carl Wells Hall, III
 George C. Spelman, Jr.

ATENTS

H. F. Robinson, Chairman
 N. W. Conner, Vice Chairman
 W. O. Doggett
 E. E. Durham
 R. L. Lovvorn
 H. B. Smith, Jr.
 R. W. Work

EFUND OF FEES

A. C. Barefoot, Chairman
 A. M. Hoch
 R. E. McCollum
 W. R. Styons
Student Member
 Linwood J. Harris, Ex Officio

RESEARCH

H. F. Robinson, Chairman
 W. O. Doggett
 E. L. Ellwood
 R. W. Greenlaw
 C. H. Kahn
 A. S. Knowles (Senate)
 S. E. Newman
 W. J. Peterson
 H. B. Smith, Jr.
 H. A. Stewart
 R. W. Work
 G. E. Musser, Ex Officio

AFETY AND HEALTH FOR THE REACTOR AND RADIOISOTOPES

Term expires
 Sept. 1

Hayne Palmour, III, Chairman 1968
 W. O. Doggett, Vice Chairman 1971
 L. H. Bowen 1968
 W. J. Dobrogosz 1969
 D. E. Moreland 1969
 C. Page Fisher 1970
 D. S. Grosch 1970
 H. A. Rutherford 1971
 A. W. Waltner 1971
 L. T. Caruthers, Ex Officio
 Frank R. Kennedy, Liaison/Phys. Plant

CHOLARSHIPS AND STUDENT AID

J. W. Horn, Chairman
 R. H. Sherron, Secretary
 G. B. Blum, Jr.

R. B. Clogston
 F. E. McVay
 J. N. Perkins
 Ray Smith
 W. E. Smith (Textiles)

SOCIAL FUNCTIONS

D. B. Kesterson, Chairman
 L. R. McDonald, Secretary
 P. C. Cato
 J. M. Parker

Miss V. M. Prichard

Student Members

Thomas D. Calloway
 James W. Goldsmith
 Samuel T. Hicks
 David H. Moore
 Robert P. Moore
 Eugene C. Pridgen
 Richard C. Shearin
 Robert G. Shipley, Jr.
 Paul W. Smith
 Max A. Soto

STUDENT ORIENTATION

E. P. Stahel, Chairman
 C. O. Eycke, Secretary
 Mrs. H. P. Clarkson
 W. T. Fike
 R. H. Loeppert (Senate)
 Mrs. E. W. Pohl
 L. P. Richardson
 W. E. Smith (Phys. Ed.)

Student Members

David D. Brown
 James F. Green
 Frank R. Hand, Jr.
 William W. Laws, Jr.
 Linda Rand
 Hal H. Willett, II

TELEVISION ADVISORY

E. W. Glazener, Chairman
 J. B. Adair
 H. G. Beard
 R. G. Carson, Jr.
 J. H. Cox
 Mrs. M. M. Donnelly
 R. W. Goldsmith
 W. W. Hassler
 J. I. Mason
 C. R. Pugh
 Jack Porter, Ex Officio
 W. L. Turner, Ex Officio

TRAFFIC

H. L. Owen, Chairman
 Mrs. E. T. Bentley
 Mrs. N. C. Clifton
 P. D. Cribbins
 Mrs. V. M. Dick
 M. S. Downs (Senate)
 C. L. Heimbach
 L. A. Jones
 J. A. King

